National Park Service
U.S. Department of the Interior

Cabrillo National Monument
San Diego, California

Cabrillo National Monument Rocky Intertidal Monitoring Program

Updated Protocol June 2006

ON THE COVER
Conducting Photoplots in Zone I of Cabrillo National Monument, San Diego, California.

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Bonnie J. Becker, PhD
National Park Service
Cabrillo National Monument
1800 Cabrillo Memorial Drive
San Diego, California 92106

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INTRODUCTION

Cabrillo National Monument (CABR) is a unit of the National Park Service (NPS) located on the tip of Point Loma at the mouth of San Diego Bay. Approximately 1.5 km (120 acres) of rocky shoreline is located within the administration of CABR (Figure 1). This small area is highly valued as a recreational, educational, and scientific public resource. In order to conserve these tidepools for this and future generations, NPS conducts long-term ecological monitoring under the Cabrillo Rocky Intertidal Monitoring Program (CRIMP). The goals of CRIMP are:

- To collect long-term, baseline information on the "ecological health" of the rocky intertidal area, and to determine normal limits of variation.
- To be conducted in perpetuity.
    - *In order to maintain the program in the long-term, all techniques should be doable by volunteers with limited training and basic supervision (by a non-expert) with oversight by a limited number of experienced staff. In addition, the program should be low-cost.*
- To determine differences between the three zones, which experience very different amounts of visitation, and to determine the effects of the closure of Zone III.
- To be comparable and compatible with existing data and similar programs in southern California.
    - *Large changes in existing protocols can only be made after consultation with these other programs. Measurements for additional components that are unique to CABR are acceptable.*
- To detect large changes in community structure reasonably quickly.
    - *Correlation of this temporal data with other factors (environmental, anthropogenic) should guide further research to determine causation of trends of concern.*
- To provide for baseline data in case of an acute disturbance (e.g. oil spill, sewage spill, rip rap), and to serve as an opportunity for public education and outreach.

(Becker 2006)

CRIMP was initiated by Dr. Jack Engle (University of California, Santa Barbara, UCSB) and Gary Davis (NPS) in the spring of 1990 based on a similar program from the Channel Islands National Park (CHIS). This original program was funded by the Cabrillo Historical Association (now the Cabrillo National Monument Foundation) and was conducted by Engle, Davis, park staff, and volunteers. The original protocol for CRIMP was described in Engle and Davis (1996).

In 1996, Engle and Davis conducted a 5-year analysis of their monitoring data and determined that seven out of the 13 species monitored had either declined or disappeared from the park. As a response to this report, CABR instituted the Tidepool Protection Education and Restoration Program (TPERP), which included increased education and enforcement of existing park regulations, the closure of one-third of the tidepools to all

visitors, and the institutionalization of CRIMP. As a result of TPERP, CRIMP has been funded from ONPS funds since 1997, and since 1998 has had a dedicated staff marine biologist. The results of the first five years of CRIMP, including some of the history of its establishment, are described in Engle and Davis (2000a). An updated protocol was produced in 2000 (Engle and Davis 2000b), although this document did not reflect changes in CRIMP that were made after 1998.

In 1997, CRIMP, CHIS, and a number of similar intertidal monitoring programs formed the Multi-Agency Rocky Intertidal Network (MARINe, www.marine.gov) in order to create a regional long-term dataset for California rocky shores. This has been achieved by standardizing existing protocols of existing monitoring groups throughout the area, creating a centralized database, and providing opportunities for large-scale analyses. When CRIMP became part of MARINe, a number of methodological changes and additions were made to the original program. The current MARINe protocol is still evolving, but is well-described in Engle (2006). The current CRIMP protocol described in this document represents a compromise between its original goals and its obligations to remain standardized with MARINe. The centralized MARINe database has been completed and can be found on a private webpage that can be accessed with a password from www.marine.gov; its usage is described in Bealer and Cooper (2003). The CRIMP database (Tidebase) and the MARINe database were integrated in 2005 and their links are described in this document.

In 2001, a statistical and methodological review of CRIMP itself was conducted, including a power analysis and a workshop, to evaluate its efficacy and solicit recommendations for improvements (Becker 2003). Many changes were adopted in the years after this workshop (2001-2006), including conversion from film to digital photography, replacement of line intercept with point contact transects, a new boundary for bird counts, increased taxonomic specificity, and addition of new plots. In 2006, another synthetic analysis of the CRIMP data was completed (Becker 2006). This comprehensive report details most of CRIMP history and documents these changes more fully.

The purpose of this document is to serve as the current working protocol for the Cabrillo National Monument Rocky Intertidal Monitoring Program, incorporating changes since Engle and Davis 2000. This protocol incorporates current MARINe standards and should serve as the definitive source for CRIMP methodology until it is revised.

PROGRAM DESCRIPTION

Survey Area and Zones

The intertidal of CABR has been split into three contiguous "zones", each about 330 m in length, that represent different levels of visitation. The program has been designed to compare these three zones, so most samples are repeated evenly in each (with a few exceptions). Historically, these zones were named "I" (high use), "II" (middle use), and "III" (low use). MARINe considers each zone to be an individual "site" called "CAB1", "CAB2", and "CAB3" respectively. In most cases, the original naming convention (I, II, III) is used,

but in the database the MARINe convention (CAB1, CAB2, CAB3) is used. The two conventions are rather intuitive and can be used interchangeably. However, they will always be referred to as "zones", since "sites" have another meaning in CRIMP.

To reach the main parking lot from the entrance station of the park, take a right onto Cabrillo Road, follow the winding road down the hill, around a hair-pin turn, and bear left into the parking lot after the fenced-in Navy facility. There is a short path leading to the tidepools from the lot. See Figure 1 for a map of the CABR tidepools.

Zone I (CAB1): High use area

Zone I is located in the northern part of the study area. From the main parking lot, take the path leading north along the cliff edge. Follow the path as it curves to the left and down into the intertidal through the eroding sandstone cliff. Zone I extends approximately 220 m to the north and 110 m to the south of this entrance point. At average walking speeds, it should take approximately 5 minutes to walk, without heavy gear, from a car in the lot to the top of Zone I. Most of the plots are north of the entrance point, although half of the transects and some of the plots are at the bottom of the cliff at the entrance point. See Figure 2 for a map of Zone I with CRIMP plots.

Zone II (CAB2): Middle use area

Zone II is located to the south of Zone I. From the public entrance point, head south along the permanent beach under the cliffs beneath the parking lot. The northern boundary of Zone II, approximately 110 m south of the entrance point, is marked by an old outfall pipe that juts out from the cliff beneath the main tidepool parking lot. At the northern end of this zone there are a series of sandstone mesas under the cliffs. The southern border is approximately 330 m south of there and is marked by a line of reflectors bolted into the sandstone and a sign on the cliff above. The southern end of Zone II is characterized by the end of the boulder field and the beginning of the flat, featureless area of Zone III. The northern boundary of Zone II can be reached in approximately 15 minutes from a car in the lot (average walking speed without heavy equipment), but should not be done when the tide is above 1.0 feet above MLLW due to safety concerns. Approximately ten more minutes will be needed to walk to the southern boundary of Zone II. The plots are located throughout Zone II. See Figure 3 for a map of Zone II with CRIMP plots.

Zone III (CAB3): Closed area

Zone III is located at the southern end of the park, near the tip of the peninsula. It can be reached by continuing south through Zone II. Most of the area is broad and flat with few boulders or landmarks; all of the transects, as well as a handful of other plots, are located in this area. Once the deeper sections in Zones I and II are crossed, it is quite easy to walk around in this flat area of Zone III, even on mediocre low tides. At the southern end of Zone III is a line of boulders that extends south from under the Coast Guard Lighthouse. Near the row of boulders there are some deeper channels, but once they are crossed the rest of the boulder area is quite high and accessible. From Zone II, it is approximately 10 minutes by foot to the row of boulders at the southern end Zone III. It is possible to get to Zone III without crossing the other Zones by cutting through the Coast Guard property

with prior permission (a combination to a locked gate is needed). This can be done to gain access to Zone III during a higher low tide or to leave Zone III more quickly in an emergency. See Figure 4 for a map of Zone III with CRIMP plots.

Target Species Assemblages

CRIMP was established with 13 "key species". As part of MARINe, the number of species monitored has broadened considerably, and have been categorized as "Target", "Core", and "Optional" species (Engle 2005). The current list of species is shown in Table 1.

Target species

"Species or species groups specifically chosen for long-term monitoring. They dominate particular zones or biotic assemblages in rocky intertidal habitats" (Engle 2005). These are the taxa for which we have specific plots, transects, or timed searches designed to monitor. For CRIMP, our Target Species are:

- *Lottia gigantea*—Giant Owl Limpets (Circular Plots)
- *Chthamalus dalli/fissus/Balanus glandula*—Acorn Barnacles (Photoplots)*
- *Tetraclita rubescens*—Thatched Barnacles (Photoplots)*
- *Mytilus californianus* (with some *M. galloprovincialis*)—California Mussels (Photoplots)
- *Silvetia compressa*—Golden Rockweed (Photoplots)
- *Pollicipes polymerus*—Goose Barnacle (Photoplots)
- Red Algal Turf (mixed assemblage of fleshy and coralline red algae) (Transects)
- *Phyllospadix scouleri/torreyi*—Surfgrass (Transects)
- *Egregia menziesii*—Boa Kelp (Transects)
- *Haliotis cracherodii*—Black Abalone (Timed Searches)
- *Piasaster ochraceus*—Ochre Seastar (Timed Searches)

  *Acorn and thatched barnacles monitored in one set of Photoplots.

Core species

"Species, species groups, or substrates that are scored using one or more survey methods by everyone in MARINe… Some of these species only occur at northern sites, or conversely, southern sites, yet to ensure that we notice if they expand their range, we must score everywhere… Data sheets must include all core species, though core species that are absent or rarely occur at a site can be de-emphasized. Entries for all core species will be required for data submission to the MARINe database" (Engle 2005).

These are species that are always scored when encountered, but are not specifically targeted by a given plot or transect. The core species are different for transects and photoplots. See Engle (2006) for the list of MARINe core species.

Optional species

"Non-core species or species groups that one or more monitoring groups choose to score at their sites; however, for various reasons, are not appropriate or feasible for all groups to score. Since optional species will not be scored by everyone, regional comparisons of

trends for these species will be limited or not possible. Each monitoring group desiring to score optional species shall provide a list of these species to the MARINe data manager, along with mechanisms to translate optional species data to core species categories… Choosing optional species requires a commitment to monitor the species consistently for a long period of time. There is little value in scoring a species on an occasional basis (e.g., only when a particular person is available in the field to identify that species)" (Engle 2005).

The official CABR optional species are:
Colpomenia spp.—Line transects and photoplots (to be lumped with "Other Brown Algae")
Mexacanthina lugubris—Photoplots (to be lumped with "Other Invertebrates")

Consistency between CRIMP and MARINe

In addition, some differences between CRIMP and MARINe are handled directly in Tidebase and therefore do not fit into the Target/Core/Optional framework. For photoplots, some additional categories (mostly layering of mussels with other species) are scored and stored in Tidebase but are not entered into MARINe to avoid the additional levels of complexity for other monitoring groups. This setup allows for maximum flexibility—Tidebase can include extra information that is appropriately entered into MARINe to fit the standards of the rest of the group. This is done in an automated fashion (see Data Management section for more details).

These categories and how they are stored in both CRIMP and MARINe are shown in Table 1.

Plot and Transect Types

CRIMP is designed using a fixed-plot approach, meaning that repeated measurements are taken from the same locations through time. For a discussion of the pros and cons of this type of approach, see Becker (2003), Becker (2006), and Engle (2006). The sampling methods used are: circular plots (size frequency measurements), photoplots (percent cover), Transects (percent cover), timed searches (presence/absence, called "irregular plots" in MARINe protocol, Engle 2005), overview photographs (photo documentation), and site reconnaissance (standardized observations) (Table 2). Each of these methods is repeated in the three zones, with 6 circular plots (3 on the cliffs and 3 on the boulders), 5 photoplots/target species (except *Pollicipes* plots, where there are 6), 2 transects/target species, and 4 overview photo points in each zone. Due to some individual situations (replacing plots that have broken off, adding plots to track recovery of disturbance) there can be different numbers of plots in some zones (see Table 3, Table 4, and Table 5 for a list of all plots and transects with their target species as of May 2006). Timed searches and site reconnaissance occur throughout all three zones.

For all circular plots, photoplots, and transects, there are three numbers: a "zone", a "plot number", and a "site ID". The "zone" is simply the zone (I, II, or III) it is located in. The "plot number" consists of a letter that represents the target species and a number that

identifies the plot from north to south. For example M1 is the northernmost mussel plot in a zone. The plot number is not unique to a zone, i.e. there is an M1 in each zone. The letters used for the plot codes are:

Circular Plots:
- L—"Lottia" (*Lottia gigantea* Circular Plot)

Photoplots:
- B—"Barnacle" (*Chthamalus dalli/fissus/Balanus glandula/ Tetraclita rubescens*)
- M—"Mussel" (*Mytilus californianus*)
- Pe—"*Pelvetia*" (*Silvetia compressa*, formerly *Pelvetia*)
- Po—"*Pollicipes*" (*Pollicipes polymerus*)

Transects:
- T—"Turf" (Red Algal Turf)
- G—"Grass" (*Phyllospadix scouleri/torreyi*)
- K—"Kelp" (*Egregia menziesii*)

The combination of the zone and plot number is unique, but each one alone is not. To avoid possible confusion, each individual plot is also assigned a unique "site ID" (Table 3, Table 4, and Table 5). Whenever possible, both the plot number (more intuitive and easy to use) and site ID (unique and precise) should be used.

Survey Scheduling

CRIMP occurs twice per year, in the spring (February-April) and fall (October-December); ideally, sampling should occur in March and November. A "season" of activities usually takes 2-4 sampling days, depending on the number and experience of volunteers, the weather and tide conditions, and if there are any unforeseen equipment failures. It is advisable to schedule 3 days, with a possible fourth day in case of emergencies. Plan some extra activities, such as plot fixing or other park-related projects, in case work is completed early on the third day. Ask volunteers if they are willing to be available on the fourth day but tell them it is likely to be cancelled. Ideally, the sampling season should be contiguous days, although it is acceptable to break up the activities if necessary. If this occurs, try to do all of one kind of plot at the same time (e.g. all circular plots in the first group of days, all of the photoplots on the second group of days).

Most of the plots can be comfortably done at a -0.5 feet or lower, but most transects and mussel plots require tides that are -1.0 feet or lower. Therefore, schedule monitoring on the lowest possible tides with at least one day with a -1.0 tide. Start working 2-3 hours before the low tide (earlier for lower tides), as it is better to work as the tide is going out. When choosing dates, be sure to check sunset times to account for the actual amount of daylight work time. This is especially important during the fall season.

Some general advice on scheduling tidepool monitoring:

- Choose the dates as early as possible, and inform volunteers, staff, and other MARINe partners. Definitely announce the dates and times at least one month in advance.
- Start to solicit volunteers (ask for RSVPs) in an official email one month in advance. Send reminder emails two weeks, one week, and three days in advance. Different volunteers have different approaches to their schedules—some like to know months in advance and some cannot commit to an activity until the last moment. This approach usually covers all types. Keep a single spreadsheet of who has RSVPed.
- It is ideal if at least one of the days falls on a weekend. This will maximize the number of volunteers. If there are no appropriate tides on a weekend, it will probably take more time (3-4 days) to complete the monitoring due to fewer volunteers.

Personnel and Training

CRIMP has always been conducted by a cadre of Volunteers In Parks (VIPs) led by one or two trained biologists. There are many benefits to this approach: it reduces the costs of the program, serves as an educational opportunity for the VIPs, and gives citizens a sense of ownership over the resource they are helping to protect. Visitors who observe the monitoring and learn about the results of CRIMP learn about the importance of park stewardship and are often inspired to become volunteers as well. However, in order to maintain the quality of the CRIMP data and maintain its consistency with the more sophisticated MARINe program, it is important that the VIPs are appropriately trained and supervised.

CRIMP VIPs represent a range of experience—some have been involved in the program for years, some have been involved for a short time but have been very active, some are newer but are interested in long term involvement, and some are only interested in helping once or twice for a novel experience or class credit. There are a corresponding range of activities for CRIMP that can be assigned to these different types of volunteers. The least experienced should be recorders, find plots, clean plots, assist in fixing plots, or work with the photographer of photoplots. People with some experience can also learn how to read transects and measure owl limpets with the supervision of a highly experienced volunteer. The most experienced volunteers can teach others to read transects and measure limpets. Experienced volunteers who can identify all of the species on the Timed Search logsheet and can mark their position on the site map can conduct the timed searches. Only very experienced participants should take photographs for the photoplots or the overview photos. In order to do the Site Reconnaissance or score the slides, the participant must know how to identify all of the core species; in most cases, only the park marine biologist will do these activities.

Generally, all participants should be assigned into teams with at least one leader who is very experienced. Depending on the number of volunteers, the *ideal* numbers of people in teams for each activity are:

- Plot Finding: At least 2
- Circular Plots: 2 measurers, 1 recorder
- Line Transects: 1 measurer, 1 recorder, 1 line holder to switch with measurer

- Photoplots: 1 photographer, 1 recorder, 1 shader, 3 scouts
- Timed Searches: 1 searcher
- Overviews: 1 photographer, 1 recorder
- Site Reconnaissance: 1 recorder
- Plot fixing: At least 2

Training volunteers happens on a few different levels. A short primer (see Appendix A) that describes the activities is sent or emailed to new volunteers when they sign up. A half-hour orientation meeting is held before the normal meeting time every day and all new volunteers are asked to come. New volunteers are told that they must attend this orientation once before they begin working, although if necessary they can attend on their second day. At this orientation, the volunteer is asked to fill out their official paperwork and is introduced to the purpose, history, and logistics of the CRIMP study. The primer is given to the volunteers again and is explained to volunteers point by point. In addition, a series of laminated sheets are used for graphic demonstration of ideas (including photographs, graphs, and example logsheets that have been filled out). An opportunity is given for questions. After this official training, the whole group should work together on one or two circular plots and test each other on owl limpet identification. In addition, the group should work on one line transect and test each other on algal identification. This is useful for some of the more experienced volunteers who need a brief refresher on some of the more subtle aspects of these activities. Once these group refreshers are done, all new volunteers are put in a team with an experienced volunteer who will continue to train them throughout the day on their specific activity. By using multiple modalities, volunteers with different learning styles will have the maximum opportunity to be well-trained and the whole group is most likely to be consistent and sharp in their activities.

Logistics

Prior to tidepool monitoring, volunteers need to be recruited and scheduled and supplies need to be organized. It is best to keep supplies in a central location to ease organization. Use an equipment checklist (Table 6) to make sure you do not forget anything. Be sure to make copies of all logsheets (preferably on waterproof paper) and volunteer paperwork, charge all electronics (cameras, flashes, batteries), lubricate the o-rings in all waterproof cases (camera case and strobe), and bring water for the participants.

The group should meet in the tidepool parking lot. Account for some extra time for organizing and socializing, especially on the first day. Gear is split among the participants in backpacks and volunteer vests and carried down to the tidepools. Quadrats can be held together with bungees for easier carrying. Be sure to tell the volunteers to be prepared for varied weather conditions, with layers and a change of clothes. Shoes should be sturdy and able to get wet. They should be told to bring food, water, sunglasses, sunscreen and a hat. See Appendix B for a standard set of instructions sent to volunteers.

If there are enough sampling days, it is often helpful to spend the first day finding and repairing plots. See below for more details about these activities. If time is an issue, one or two teams can be sent to find plots while the rest of the group begins monitoring on the

first day, leaving plot repair for the last day. Throughout the monitoring season, the order of activities should be dictated by the tide level. Always take advantage of lower tides to do deeper plots and transects. It will be important to also do the "whole plot" activities—overview photos and timed searches—when the tide is out as well. Therefore, do not waste low tide time on higher plots such as circular plots on cliffs and goose barnacle plots. Always work from deep to shallow. Deeper plots are usually easy to identify visually on a map, but in general, the following pattern holds:

Higher plots: Po, L, Pe
Middle plots: B, T
Lower plots: M, G, K

For a list of monitoring tasks, see Table 7.

Plot Finding, Marking, and Cleaning

All fixed plots are marked with permanent markers. Circular plots are marked with a single central bolt. Photoplots are marked on four corners with bolts or plain blobs of epoxy (usually on the boulders which are too hard to practically drill in multiple bolts). Line transects are marked with three bolts oriented in a line. Overview photo points are marked with a single bolt. Timed searches and site reconnaissance do not have fixed markers.

All bolts are stainless steel hex bolts (except a few old copper bolts) surrounded by a mound of marine epoxy (Z-Spar A-788 Splash Zone Compound, available at marine supply stores). There are a number of additional bolts in the area from other research projects that have different shapes, but none of them are hex bolts or smaller copper bolts. All future research projects or park projects should not involve the installation of similar looking bolts to the tidepool monitoring bolts to minimize confusion.

Finding the plots can be quite challenging, but there are a number of tools that make this activity easier. Appendix C is a detailed photographic and georeferenced guide to all of the plots. This guide includes maps, interplot measurements, GPS measurements, tidal heights, text descriptions and multiple photographs for each plot. This guide, created in winter 2006, should be considered the definitive authority on plot orientation and should be consulted often to avoid changes in plot orientation through time, especially for photoplots. It should be kept up to date with changes and additions.

At the beginning of each sampling season, all the plots and transects should be found and marked with tape. Use white tape to mark circular plots, orange or red tape to mark photoplots, and yellow tape to mark line transects. Use permanent marker to write the plot number on the tape. Tape should be attached to bolts, if the exist, or to a solid organism if there are no bolts. Care should be taken not to disturb the plots or transects while finding and marking them, including disturbing vegetation or adding tape in the middle of photoplots.

Once the plots are found, all bolts and blobs should be thoroughly cleaned of fouling organisms. This can be done with stiff wire brushes (barbeque cleaning brushes), butter

knives, metal putty knives, or other robust scraping supplies. Be very careful not to disturb the plot while cleaning it. This must be done every season. It takes remarkably little time for these markers to be overgrown, leading to inaccurate placement of plots and long-term loss of data. During this cleaning phase, missing markers should be noted.

Plot Repair and Replacement

Missing markers should be fixed every season. It is easiest if missing markers are fixed at the beginning of a sampling season so that the monitoring is done with the plots in the best possible condition. However, if time is an issue, plot repair can be done at the end of the season (or some can be done before and some after). Priority should be given to missing markers that make orientation of the plots challenging (missing circular plot bolts, photoplots with multiple corners missing, northern or southern bolts of transects missing). Use the plot guide to accurately relocate the plot and determine the locations of replacement markers. If relocation of the plot is difficult due to missing blobs, collect as much information as possible (print out archival photos, photoplot photos, plot guide photos, GPS information) and use as much evidence as possible to find the original position. If relocation is difficult due to missing rocks (i.e. if cliff erosion removes plot entirely), it might be necessary to drop the plot to the nearest surface.

In order to replace a blob, clear off a small patch of rock, and use a turkey baster to remove all debris from the rock. It is necessary that the rock is clean but not dry. Mix equal parts of marine epoxy (black and brown), adding a little seawater to keep it from sticking. Wear rubber gloves to protect your hands while doing this. After the epoxy is well-mixed, apply it directly to the clean rock in the shape of a blob. Form a shape that will be easy to find again in the future after it is overgrown (a peak, a square, a bulb). Using a butter or putty knife carve the plot number into the epoxy. If it is a corner of a photoplot, carve the letters UL, LL, UR, or LR to signify which corner it is.

In order to replace bolts, a drill is necessary. Use a Boschhammer SDS Electric Rotary Hammer Drill (11225VSRH) with a ½" Bosch SDS Plus bit (HC2081). Use the hammer mode for drilling into the harder volcanic rock and the regular mode for the more brittle sandstone. Be sure to use eye and ear protection while using the drill. Clear off a space on the rock and drill the hole. Clean out the hole well using a turkey baster. The dust will preclude the adhesion of the marine epoxy, so it is important to remove it. The bolts are stainless steel (4-6" long, 3/8" diameter) hex bolts. Mix some marine epoxy (as described above) and form a thin "snake" between your hands. Feed the snake into the hole. Put the bolt into the hole and tap it so that the bolt is forced into the hole full of epoxy. Make the bolt high enough to be easily found, but be aware of tripping hazards for the public. Bolts for circular plots should be high enough to put measuring tapes around. Once the bolt is positioned in the hole, surround the base with more epoxy, and carve the plot number in the mound of putty.

In some cases, it might become necessary or desirable to add a new plot or transect. This might occur if the original target species has declined dramatically in a given plot, leading to a need to create a new plot that tracks the target species better (such as the addition of L7 and L8 in Zone II). There are some guidelines and recommendations on how to do this

in Engle (2006). It is important to note that the original plots should not be removed. Do not reuse numbers for new plots. Once a new plot is added, it is crucial to document its location using site photos, GPS, interplot measurements, and the map. The plot finding guide should be updated accordingly.

Logsheets

Logsheets are designed to meet a number of purposes. They serve to remind the field workers of all of the information they need to collect and help to standardize and regulate the data collected. They should be clear, uncluttered, and easy to read and write on. While they should be efficient for the field worker, they should also make the data entry process easy and minimize entry errors. Logsheets also serve to document which species were consistently searched for. This is important when trying to determine whether a species was absent or whether its presence was not noted (i.e. to discriminate between "0" and "ND").

The logsheets used in CRIMP (Appendix D) have been developed over many years to meet the needs of the program. Historical logsheets can be found in binders in the Natural Resource Science Office. As CRIMP evolves further, the logsheets should be adapted to reflect these changes. Changes in the logsheets should be archived and documented. Ensure observers understand which species listed on logsheets are to be consistently looked for and that there is a clear mechanism to discriminate between "0" (they were looked for, but none were found) and "ND" (they were not looked for, no way to know if they were present or not).

Prior to the sampling season, photocopies should be made of all logsheets. It is most efficient to keep an electronic folder with the current versions as well as a paper folder with hard-copy master versions of the logsheets. Then make more than enough copies of all logsheets, ideally on waterproof photocopy paper. (Do not use waterproof paper in a laser printer unless it is specifically designed for laser printers).

Instruct volunteers how to fill in logsheets correctly. It is often useful to show them example logsheets of each type. Remind them to write clearly, use a pencil, fill in all blanks, use complete names and dates, and total Circular Plot logsheets. Explain the difference between zone numbers, plots numbers, and site numbers, and ask them to use all three numbers on all logsheets.

At the end of each sampling day, review each logsheet for obvious problems (e.g. missing dates, recorders, or plot numbers). Maintain a running spreadsheet of which plots have completed logsheets as the final check that all plots have been done. Keep all logsheets together until the end of the season. Soon after the end of the season, photocopy all logsheets. These copies should be put in a folder and stored offsite as a backup copy in case of catastrophic loss of data. The originals should be stored in a binder.

SURVEY METHODS

Daily Field Log

The purpose of the Daily Field Log is to document the activities of the day, the working conditions, the participants, and provide a standard format for recording some basic observations about the site. This form serves as the place to record metadata about the data for the day, to record comments, and is the first thing that is entered into the database to provide a record for the sampling day. These comments will be put into the database, and will serve as a long-term, searchable archive for anecdotal observations about the park.

All blanks should be filled in on the logsheet. Note if a bird census was done and if "Seasonal Observations for a Single Zone" (Zone Observations) and "Site-Wide Species Conditions" (Site Reconnaissance) forms were filled out as well as weather conditions, with an emphasis towards conditions that would affect quality of sampling. When filling out "Weather and Sea Conditions", be sure to use the existing codes (--, 0, L, M, H, or a number for the water temperature). Do not use intermediate codes (e.g. L/M) as they will not be accepted into the database). If no data were collected, fill in a dash—do not leave the space blank. Use judgment when filling out relative values (e.g. is this wind high for normal conditions here? Has it rained in the past day or two?) and try to have the same person fill in this form for consistency. Water temperature should be taken further out in an area with a clear connection and flow to the ocean. Note any physical or biological conditions of interest (sand levels, numbers of *Aplysia*, nudibranchs, surfgrass condition, and unusual animals). Note the number of dogs and marine mammals seen throughout the day by anyone in the team (do not make a special effort to look) in all three zones; be sure to record 0's if none were found so that it is clear that this was not simply omitted.

The Daily Field Log can be filled in throughout the day, usually by the park marine biologist. It is best if all observations are done while still in the field, at the end of the day. The back of the sheet can be used if necessary.

Note that the rest of MARINe tends to monitor a single site in a single day, so the Daily Field Log, Zone Observations, and Site Reconnaissance are all conducted on a single form. Since the three zones of CABR are monitored over the course of three days, it is easier to separate the Daily Field Log (e.g. observations about the day, working conditions, activities documentation) from the seasonal observations for a single zone (e.g. changes in substratum, biological and physical changes). In other words, the Daily Field Log is for the day (all three zones together), while the Zone Observations are for the whole season (each zone separately). This is reflected in the existing logsheets and in Tidebase, and is automatically adjusted when Tidebase is converted to MARINe.

Circular Plots

The purpose of circular plots is to measure all of the *Lottia gigantea* (giant owl limpets) in a 1 m radius circle of a single central bolt. This is done by attaching a 1 m length of line (or a

precut measuring tape) to the bolt, and swinging the line around the bolt while carefully searching the area for limpets. Be sure to check under all cracks and crevices, between mussels and other organisms, and under patches of algae, as limpets can be quite cryptic and fouled with other organisms. A small flashlight can be quite helpful. All owl limpets that can be touched with the tape, regardless of the bumps and dips between the bolt and the limpet, are considered inside the circle. This includes those underneath the ridges—if they can be touched by the tape, they are in the circle.

Measure limpets to the nearest 1 mm with metal calipers, call out the measurement to a recorder, and mark the limpet with forestry crayon to avoid double measurement. Limpets smaller than 15 mm should not be measured because they are difficult to identify correctly. Be sure to check the calipers carefully—the zero mark can be located in different places leading to different ways of reading them. If a limpet is hard to measure because of its location (i.e. deep in a crevice), estimate its size using the back or end of the calipers; never remove a limpet from the rock. If there is more than one measurer, use two different colors of crayon to check each other's work. Each recorder should start on opposite ends of the plot and work on separate semicircles and then switch to check each other. As the measurers call out numbers, the recorder should repeat back the numbers and then make a "tick mark" on the logsheet next to the size (cross after every five tick marks). At the end of the plot, the recorder should tally up the number of limpets in each size class (e.g. to avoid confusion, write and circle 2 next to two tick marks ‖, which could be confused for 11) as well as the total number of limpets in the plot. It is often more comfortable for both measurers and recorders to use foam gardening pads to sit and lean on while working on circular plots.

The most challenging aspect of circular plots is correctly identifying *Lottia gigantea* from the other species of limpets that live in this habitat. It is crucial that all measurers receive some training on limpet identification prior to measuring limpets, and that at least one member of each team is highly experienced in identification. It is recommended that on the first day of the season, the whole group work on one or two plots together and test each other on identifying limpets to make sure that each person's skills are current and consistent.

See Appendix D for the Owl Limpet logsheet.

Photoplots

The purpose of photoplots is to determine the percent cover of various core taxa within a fixed 50 cm x 75 cm rectangle. Photoplots target four main assemblages: barnacles, mussels, rockweed, and goose barnacles. This activity is done in two phases: photographs are taken in the field and are scored later in the office.

Taking photos

Photos are taken with a digital camera protected in a waterproof housing with a waterproof strobe mounted on a PVC frame. The strobe, controlled using a TTL sensor, is used to fill in shadows. The PVC frame, or quadrapod (see Figure 5), is designed to create a

stable and consistent platform to produce the same perspective in the photograph. When the camera is mounted on the quadrapod and set at its widest angle, the rectangle of the quadrapod is at the edges of the frame. The digital camera is quite sensitive to bright spots in the frame, so it is helpful if the quadrapod is painted gray or black or is made of darker PVC. Fill the housing with freshly recharged desiccant packs to avoid fogging. The camera and strobe should be charged and the memory cards empty before the monitoring begins.

The settings used for the camera and strobe should be determined empirically—they should be what works best for the most situations for the specific camera setup. In May 2006, the photoplot camera was an Olympus Camedia C-5050 Zoom with an Ikelite Digital Housing, and an Ikelite Digital Substrobe DS125 controlled by a DS EV Sensor. The settings used for the camera are dial-P, pic-SHQ-2560x1920, flash-always on, and lens at its widest angle. Read the camera manual for more information. It is often easier to set these before placing the camera in the housing. The settings will remain until the batteries are removed from the camera. Set the strobe to TTL and the EV controller to 1. See Figure 5 for more details on this particular setup. If this setup changes, go to the tidepools and retest the settings empirically. Do this on a separate day so that the photos can be checked on the computer. The only goal is that the end result is easy to score on the computer screen.

In the field, it is helpful if the photographer is assisted by a team consisting of a recorder, a shader, and a few people to search ahead for plots. The scouts should work ahead of the rest of the team, placing PVC quadrats (rectangles measured to the same size as the base of the quadrapod) oriented appropriately on each photoplot. Be very careful not to disturb the plots while looking for them and marking them. This is especially important on rockweed plots, where the markers are often buried under layers of rockweed; simply feel under the seaweed or gently lift it and place it back in the same orientation in which it was found. Use the dry surface of the rockweed as a guide. Remove all of the drift kelp and other debris that is not attached to the substrate.

The order in which the photos are taken will be dictated by the tides—always work from the deepest available plots inwards. Remove the marker quadrat. The quadrapod should be placed carefully over the photoplot without disturbing the organisms within it. The orientation of the photoplot is important, so be sure to double check the plot guide. Use a dry erase marker to write the season, the zone, and the plot number on the tile in the corner of the quadrapod base. Using a car shade or a dark umbrella, shade the photoplot well. It is important not to have any bright spots in the frame as they tend to flare in the digital camera sensor. Use the strobe, set to light the plot from the side, to light the plot rather than the sun. Take the photograph and check the composition in the preview screen. The recorder should note the zone, plot, and site numbers, and should keep track of the frame numbers in the Photo Log. As the team progresses, the recorder and the photographer should regularly communicate the frame number to be sure that they are aligned. It is often difficult to determine one plot from another once the photos are back in the office. The Photo Log can be very helpful when the labels are hard to read in the photo. The recorder should also note the settings the photographer used. If the settings are consistent throughout the day, they only need to note them once, but mention that they were used all day.

There are some species and situations that are particularly difficult to score. In these cases, field notes are often quite useful. This can be done more casually by dictating comments to the recorder to add to the photo log. Some of the common notes include dead or very small barnacles, depth of sand, bleached coralline crusts, darkened rock, and presence of *Phragmatopoma*, *Serpulorbis*, *Chthamalus*, or *Mexacanthina*. Alternatively, a rough sketch of the plot can be made on an optional photo sketch logsheet. This decision should be the preference of the scorer. Try to resist the temptation to spend more time taking notes on plots than it would to score them in the field. It is ideal if the same person takes the photos and notes on the plots as scores the photos in the office later.

At the end of each sampling day, download the photos to the computer. It is ideal if the photos are immediately labeled (i.e. files renamed) to avoid confusion. Use the photo log and the label in the corner to double check each plot before labeling. File names should follow marine conventions (Engle 2005):

- Site: CAB1, CAB2, CAB3
- Target Species: bar, myt, sil, pol
- Plot Number: 1, 2, 3, 4, 5, 6
- Season: fa (oct-jan*), sp (feb-may), su (jun-sept)
- Year: last two numbers only
- Photo Replicate: a (the one we scored), b-f (additional photos not scored), g (scored photo with grid overlay)
- Photo variants: can be used for some different perspectives or subsections, such as subsamples or taken over a ledge.

*Due to oddities of the low tide season, January samples are included in fall of the previous year. For example, January 2005 would be included in FA04. There is no winter season.

This is put together in a format: "site" "_" "target species" "plot #" "_" "season" "year" "replicate" "_" "variant" ".jpg". For example, cab1_myt1_SP06a.jpg is Zone I, M1, spring 2006, and the photo that was scored.

Photos should be placed in a single folder for the season, labeled with the season number (from Tidebase and MARINe, see Data Management section) and the season code. For example, spring 2006 is in a folder called 101_SP06. This will make the folders sort in chronological order. The photos should then be imported into Photoshop and appropriate tags should be added.

The required photo log and optional photo sketch logsheet can be found in Appendix D.

Scoring photos

Slides are scored digitally in Photoshop by overlaying a grid of 100 evenly-space points over the photograph and recording the cover under each point. The instructions below should be supplemented with the software manual for Adobe Photoshop.

It is helpful to tag and manage the photographs in the Organizer of Photoshop, and score the photos in the Standard Editor of Photoshop. It is easiest to have the following three side palettes open in the "Palette Bin" on the side of the Standard Editor window: "Navigator", "Layers", and "Undo History". If one of these is not already open, they can be found under "Window" by selecting the palette of interest. The palette will open in the main window, but not in the palette bin. To get it to attach to the side bin click on"More">"Place in Palette Bin", and then close the palette; it should now appear on the side. Remove all other side palettes (besides the three listed above) by sliding them into the main window, clicking "More", unclicking "Place in Palette Bin", and closing them.

Open the file "grid with small points colors.psd" in the Standard Editor. This is a Photoshop file with a grid of 100-evenly spaced points. It is actually a bunch of layers of different sized and colored dots and points: big yellow dots with red outline, black points, white points, and yellow points. The big dot layer also has some lines that separate the dots into quadrats of 25 points. This layer is useful for lining up the points and for keeping track of location while scoring the slide. The different color points are used for finding the specific point to score, and each color works best to contrast with different colors on photographs. Use the Layers palette in the side bin to turn the different layers on and off to utilize these different guides and points. In addition to setting up the Palette Bin and opening the grid file, collect the following supplies: photoplot notes, logsheets, pencil, laboratory counter, Post-it notes, scissors, and Sharpie marker.

If there are multiple photos for a given photoplot, choose the best exposure and orientation in the Organizer window of Photoshop. Label it appropriately (see labeling description in the "Taking Photos section above). Open the photograph in the Standard Editor window of Photoshop. If necessary, improve the exposure using the histogram function ("Enhance">"Adjust Lighting">"Levels") by sliding the black and white triangles until they are in line with the edges of the histogram. Drag the grid onto the photo. This can be done by lining up the photo and the grid ("Window">"Image">"Tile"), select the "Move Tool" (shft-V, the top tool on the left), and drag the grid from the grid window onto the photo. Maximize the photo window. At this point the grid should be in free-transform mode (if not, ctrl-t), and the grid should be moved and stretched so that the points cover as much of the photo as possible. The corners can be twisted to rotate the grid if necessary. Once the grid is appropriately placed, press return to accept the transform.

In order to score the slide, zoom into the photo to an appropriate level where the cover is clear and not pixilated (the navigator palette is useful for this). Use the layer palette to remove the big dots and use the smaller points to determine where to score. Layers can be removed until the best color is found for a given part of the photograph. If a small part of the photograph is too dark or too light, it is possible to adjust the brightness or contrast by selecting using a marquee. Use the Rectangular Marquee Tool, the Elliptical Marquee Tool, or the Selection Brush Tool on the left hand tool bar to select the area of interest. Then use the tools under "Enhance">"Adjust Lighting" to improve the exposure of the area. (A few hints about exposure: It is worth learning how to use the "Levels" tool under "Adjust

Lighting" for this purpose. Try using contrast in addition to brightness and darkness to improve ability to discern difficult organisms. Use the Undo History palette to selectively undo mistakes.)

It is easiest to start in the upper left quarter of the slide, scoring the top row of five from left to right, then the second row of five from right to left, then the third row from left to right, etc. until the first quarter is finished. At this point, use the navigator palette to move to the upper right quarter and score the top row of five from left to right and so on until the second quarter is finished. Then move to the lower right quarter and then the lower left quarter. By scoring in the same direction consistently, and checking the total number of points often, fewer errors will be made and plots will not need to be repeated.

There are many subtleties to scoring photoplots, which are outlined in detail in the MARINe protocol (Engle 2005). There are also some differences between CRIMP and MARINe. This protocol should be followed and the MARINe standards are met through the standardization between Tidebase and the MARINe database:

- "Always score the top-most (visible) layer that is attached to the substrate (i.e. not an obvious epibiont) unless the top-most layer is a "weedy" species obviously overlaying a non-weedy species". So, basically score what is on top, except…
    - …if what is on top is a "weedy" species (*Ulva*, *Enderachne*, *Scytosiphon*) and it is obvious what is underneath it, score what is underneath it and ignore the weedy species. If it is not obvious what is underneath it, score it as the weedy species.
    - …if what is on top is not attached to the rock, like non-coralline crust growing on a mussel, or articulated coralline algae growing on *Tetraclita*.
    - There are a number of layers that we do record in CRIMP that MARINe does not record. They are later resolved by the database. These were chosen because they are extremely common in our photoplots and we wanted to keep track of plots that are getting overgrown. For example, many of our mussel plots are almost entirely covered in red algae with mussels struggling underneath them. Only these layers should be recorded, but they should be considered as required (i.e. they are always looked for and "0s" are listed when they are not found). Below is a list of the layers that are included in Tidebase with the MARINe resolution in parentheses.
        - Articulated corallines on *Mytilus* (*Mytilus*)
        - *Chthamalus* on *Mytilus* (*Mytilus*)
        - *Chthamalus* on *Tetraclita* (*Tetraclita*)
        - *Enderachne* on *Mytilus* (*Mytilus*)
        - *Enderachne* on *Tetraclita* (*Tetraclita*)
        - Limpets on *Mytilus* (*Mytilus*)
        - Other red algae on *Mytilus* (*Mytilus*)
        - Other red algae on *Pollicipes* (*Pollicipes*)
        - Other red algae on *Tetraclita* (*Tetraclita*)
        - *Silvetia* on *Mytilus* (*Silvetia*)
        - *Tetraclita* on *Mytilus* (*Mytilus*)

- Specific mobile invertebrates should be scored if they have specific categories on the logsheet: chitons, limpets (not *Lottia gigantea*), *Lottia gigantea*, *Mexacanthina lugubris*, and *Pisaster ochraceus*. All other mobile invertebrates should not be scored (do not score them as "Other Invertebrates" and what is underneath them should be scored (make a note in *Comments* that this has been done). If what is beneath them is not known, score as "Unidentified". Use "Other Invertebrates" for sessile invertebrates that do not have an existing category, such as *Serpulorbis* (also note in *Comments* what species they are, if known).
- Score the putty corners as "rock".
- Score barnacles scars as "rock".
- Score bleached crustose corallines that appear white as "crustose corallines".
- Score dead shells and tests as "other substrates".
- "Sand" should only be scored if what is under can not be identified. Do not score a thin layer of sand. There is no longer a category "Sand Turf" that was once used in legacy data. This messy mixture of turfy algae and sand is usually best scored as "Other Red Algae", which is the most generic category to describe that substance.
- Try to score every point. There are a number of valid reasons why a point is unscorable. This can be recorded as generic, or given a reason code:
    - Drift Algae—it is better to remove drift algae, but sometimes it is forgotten or difficult to remove. If it is obvious what is under it, then score what is under it. If it is not obvious what is under it, score it as "Unscorable—Drift Algae". Do not score drift algae as the species it is if it is unattached (e.g. a piece of *Egregia* that is not attached to the substrate should not be scored as *Egregia*).
    - Off Rock Edge—When the grid falls off of the rock edge, even if you can identify what is beyond the boulder, score it as "Unscorable".
    - Shadow—After adjusting the exposure and the contrast, some points are still not identifiable. This can occur when the area is too dark or too light. This is very common in Po plots.
    - Shoe—Occasionally, the photographer's shoe gets in the way of the photograph. Try to avoid this problem when photographing the plots.

  It is often possible to orient the points to avoid unscorable points. This can be done, but care should be taken not to bias the location of the points to repeatedly avoid parts of the plot. A few unscorable points are preferable to not scoring a strip of the plot.
- Be careful of:
    - Discolored rock that can look like non-coralline crust
    - Anemones covered in shells
    - *Phragmatopoma* and *Serpulorbis* growing underneath other organisms
    - Non-coralline crust that looks like tar
    - Organisms growing on top of mussels or *Tetraclita*

It is generally useful to compare a given point to the area around it. For example, what does non-coralline crust look like in that photograph? Is there Phragmatopoma in that type of habitat or in the rest of the photograph?

One approach to scoring slides is to use the laboratory counter for the most common species, and then use tick marks on the logsheet for the rare species. Use Post-it notes, cut into strips, to make labels for common species to put on the counter. After finishing scoring each quad, check the total number of points scored to be sure that the right number of points have been scored. After finishing all four quads, enter all of the data on the logsheet.

Save the photo with the grid overlay. This is done by making sure that all of the layers are visible (make sure the eye is clicked for each layer in the Layers palette), merge all of the layers ("Layer">"Merge Visible"), and then save the file as a .jpg file. Use the naming convention described in the "Taking Photos" section.

The Photoplot Data Logsheet can be found in Appendix D.

Point Intercept Transects

The purpose of line transects are to record the cover under 100 points along a 10 m line to determine the percent cover of various core species. Line transects focus on species that cover the flat benches of the intertidal and target three assemblages: red algal turf, surfgrass, and boa kelp. At the minimum, this should be done with one person to "read" the transect and another to record the data. It is helpful if this is done in a team of three or four. The extra people can hold the transect tapes and are available to switch with the reader to rest their backs.

Find the transect bolts. The line is marked by a northern, center, and southern bolt. The northern and southern bolts are approximately 10 m apart, with the center bolt approximately in the center (see the plot guide for anomalies from this pattern). If only two bolts are found and they are only 5 m apart, use the plot guide to double check which direction the transect goes. Stretch a meter tape (or attach a pre-cut tape) between the bolts. If the bolts are a little less than 10 m apart, start the transect at the northern bolt and stretch it beyond the southern bolt to 10 m. If they are more than 10 m apart, start at the northern bolt and stretch the tape to the southern bolt, but stop reading the transect at 10 m. Use great care not to disturb the transect while placing the line. This is particularly important for grass and kelp which can cover bolts can be easily disturbed from walking and searching.

Start reading the transect at the northern bolt, beginning at the 10 cm mark, then moving along the transect tape record the cover underneath the tape at 10 cm intervals. Use the point created by the line marking every 10 cm on the top of the tape as the precise sampling point. Only score taxa with codes on the logsheet. If the taxon found is not on the sheet, use one of the lumping categories, such as "Other Brown Algae". If the reader would like to add more detail than the code, be sure to use the official code and then add more information as *Comments*. Record what is on top (e.g. if the point hits surfgrass laying on boa kelp, score it as SG). If your point falls on something laying on surfgrass, score the upper cover as well as surfgrass understory (e.g. if the point hits boa kelp laying on surfgrass, score it as BK/SGU); this is only done for surfgrass. Do NOT record things that

are not attached to the substrate (e.g. drift algae, debris). If your point falls on drift algae, carefully remove it and record what is directly below it. When the point falls on a collection of sand, use a pinky finger to determine the depth; if it is deeper than the nail score it as sand and if not, score it as rock. Dead shells should be considered drift debris and should not be scored.

The recorder should write the code for a given point in the corresponding row in the logsheet. If the same code is found for contiguous points, use an arrow to indicate how many rows to repeat the same code. This is extremely common, especially with surfgrass, which can often dominate tens of points in a transect. It should be stressed that only the codes listed at the bottom of the logsheet can be entered into Tidebase.

For each surfgrass transect, assess the condition of the grass itself. Determine the level of *Smithora*, *Melobesia*, bleaching, abrasion, and flowers using the following codes: 0, L, M, H. These values should be estimated for the whole transect.

In order to ensure quality of data, it is advisable to have the whole group do a transect together at the beginning of the season, and to test each other on the relevant taxa. This will allow veteran volunteers to refresh their memories and provide additional training for new volunteers.

See Appendix D for the Line Transect logsheet.

Timed Searches

The purpose of timed searches is to look for species that are rare or absent from the park. Each zone is searched for half an hour by one person (or 15 minutes by two people). This provides time-standardized presence/absence data. The entire zone could be considered an "irregular plot" and the search effort is limited by time. The searcher should bring copies of the site maps with them to circle the approximate area searched. This will provide some rough information about search area. Although these timed searches are designed to target black abalone and ochre seastars, all species of abalone and sea stars are recorded when encountered. Urchin observations are always noted as well. Other species of interest can be noted when found, although not at the expense of looking for abalone and seastars.

The search should be done close to low tide by someone with familiarity with the species and their habits. The searcher should focus on abalone and seastar habitat and be prepared to get a little wet. Wander throughout the lower intertidal, looking under ledges, rocks, and at the bases of boulders. Use a small waterproof flashlight to aid the search. Measure and record any species listed on the logsheet. Measure the maximum shell length of abalone. For seastars, measure from the end of the longest leg to the center of the disk. For urchins, measure the diameter of the test (the body underneath the spines). It is acceptable to estimate the size of urchins, especially if many are found or if they are deep in crevices. Do not spend a lot of time measuring urchins. Record the habitat and other

observations about the species. Other species found can be noted on the sheet, but the focus of the search should be abalone and seastars.

At the end of the search, place zeros next to all species that were searched for but not found. The approximate area searched should be circled on a copy of the site map. This site map can be included with the logsheet hardcopies.

See Appendix D for the Timed Search logsheet. See Appendix E for a Timed Search pictorial guide to be given to volunteers.

Overview Photographs

The purpose of overview photographs is to document general conditions of the tidepools, including habitat locations and erosional features. There are four permanent overview photo points in each zone marked with a single bolt. At each point two sets of photographs are taken, one pointing towards the horizon to document a wide-angle view of the site and one pointing towards the ground to document a smaller-scale view of the site. These photographs are later stitched together to create two panoramic images for each overview photo point. These can be used for a variety of purposes in the future.

Overview photos should be taken during low tide to maximize the amount of intertidal exposed for the photographs. However, glare from the afternoon sun can make the photographs useless. In addition, if time and labor is limited during the best low tides, overview photos should not be done in lieu of photoplots, line transects, or circular plots. Overview photos can be taken during a different low tide series than the other tidepool monitoring, if necessary.

A list of overview photo points can be found in Table 8 and descriptions can be found in Appendix F. After locating and cleaning off the bolt, a photographer should set up a tripod with a digital camera over the bolt. Photos should be taken from north to south in a clockwise direction, at a higher angle first and a lower angle second. Bring photos from past years to line up the frame consistently. Subsequent photos should overlap slightly such that the whole 180° series is covered in approximately 9-12 frames. Record each series of photos (one point, upper or lower, counts as one series) including the first and last frame number on the logsheet.

At the end of the sampling day, download the overview photos immediately to avoid accidental deletion. Files should be renamed to avoid confusion. The following convention should be used.

- Season: fa (oct-jan), sp (feb-may), su (jun-sept)
- Year: last two numbers only
- Site: CAB1, CAB2, CAB3
- OV Photo Point Number: MOV01, 02, etc.
- Add an "a" if it is the lower series
- Photo Number: 01, 02, 03, etc.

For example, the fourth photo taken in the lower series during spring 2006 in Zone I at site 01 would be labeled "SP06 CAB1 MOV01a 04.jpg". It is important to use a zero before the photo number for sorting purposes. The files should be stored in folders labeled with the season number (from Tidebase and MARINe, see Data Management section) and the season code. For example, spring 2006 is in a folder called OV_101_SP06. This will make the folders sort in chronological order. The photos should then be imported into Photoshop and appropriate tags should be added.

The photos should be stitched together using Panavue stitching software. See the software manual for further instructions.

See Appendix D for the Overview Photo Log logsheet.

Zone Observations and Site Reconnaissance

The purpose of Zone Observations ("Seasonal Observations for a Single Zone") is to document general conditions of the whole zone for the whole season. The purpose of Site Reconnaissance is to standardize some anecdotal observations across MARINe so that they can be compared. The logsheets serve as reminders to the observer to look for certain species and characteristics every season. Since most MARINe groups monitor one site on one day, the Daily Field Log, the Zone Observations, and the Site Reconnaissance can be done on a single form. Since the zones of Cabrillo can be monitored over the course of multiple day, these three sheets have been separated. The Daily Field Log is done every day for the whole site, while the other two are done separately for each zone but only once for the whole season.

The Zone Observations are to be filled out by an experienced observer after spending some time in the zone looking for changes in physical and biological conditions. It is best to do this on the last day of monitoring so that observations can be made throughout the sampling season days and compiled on the last day. Be sure to fill in all blanks on the sheet. If no data are collected for one of the blanks, fill in a dash for "no data" for clarity. Be sure to use the codes (--, 0, L, M, H) and not intermediate codes (e.g. L/M) for all of the blanks since only the codes will be accepted into the database. Use the blank areas to fill in narrative comments on physical and biological conditions. List interesting species seen, such as charismatic megafauna (giant keyhole limpets, aplysia, nudibranchs, lobsters, abalone or seastars not found during timed searches, etc.). Explain important or interesting events that have occurred throughout the year. Ask other participants to contribute their observations.

The Site Reconnaissance ("Site-Wide Species Conditions") is to be filled out be an observer familiar with the site and the species listed on the logsheet. Observations are not needed for every species, but be sure to draw a lie across the row for species for which no data were collected. Focus on the species in bold if there is limited time. Be sure to use the codes (e.g. --, 0, L, M, H) and not intermediate codes (e.g. L/M) for all of the blanks since only the codes will be accepted into the database. Abundances are relative to "the site-

wide condition of the species within its optimum zone" (Engle 2005). In other words, what is the abundance of this species relative to how abundant it could be at this site in its normal habitat. When appropriate and possible, record information about fertility, bleaching, damage, and recruitment. Notes can be added in the notes column, and at the bottom of the sheet. Information can be added about additional species at the bottom as well.

When time is short for the monitoring season, less time should be spent on Zone Observations and Site Reconnaissance to free up more time to finish photoplots, line transects, and circular plots.

See Appendix D for the Zone Observation and Site Reconnaissance logsheets.

DATA MANAGEMENT

Overview—Tidebase

The data from CRIMP is stored in a Microsoft Access database called "tidebase.mdb". In addition, the data are submitted to a centralized database for the MARINe group. Tidebase holds more information than MARINe, and has been built to automatically send the appropriate data to MARINe to reduce duplicate effort and entry errors. Therefore, data will be entered directly into Tidebase, and entered into MARINe subsequently using automated append queries later.

Basic Structure

Tidebase is a relational database. It is beyond the scope of this protocol to serve as a manual for MS Access, and it a program manual is highly recommended. Tidebase has been designed with forms and queries that can be used by a casual user and data entry worker, but a more advanced Access user can take advantage of its more powerful features. This protocol will describe some of the specific attributes of this database and serve as a primer for beginners to enter and manage the data. (Beginners can skip the rest of this section and skip to the Workflow section, as there are forms and switchboards that interface with the tables described below; do not open or change these tables without some knowledge of MS Access).

Tidebase consists of a series of tables (Table 9) that are described below. The first few letters of titles of the tables indicate the types of information stored within. Tables that begin with "lu" are "lookup" tables; they include information that is used in the other tables, forms, and queries, and serve as keys or informational tables to describe species names, data codes, plots, etc. The actual CRIMP data are stored in "data" tables, beginning with "tbl". These data tables fall into a few different subcategories: "Data", "Info", and "Measurers". "Info" has information about who recorded for an individual plot, and specific information about the data collection and entry at a given plot; there is usually one line of data for a plot for a given season. "Data" has the just the actual information, such as the number of limpets in each size class; there are usually multiple

lines of data for each plot. In addition, multiple measurers are stored for each plot in the "Measurers" table; again, there can be multiple rows for one plot. The table titles begin with "M" (i.e. "Mtbl" and "Mlu") are also lookup and data tables but they are linked with the MARINe databases. The function of these tables will be explained in the MARINe Integration section below. The last tables, beginning with "xxx", are odd tables that do not fit any of the other categories, but that are useful. They include legacy transect data which have been collected in different ways (e.g. 1000 points instead of 100 points) and were converted to the current format. Rather than deleting the old data, they have been stored in legacy tables. See the descriptions for each table (Table 9) for more information about the xxx tables.

These tables are linked in a series of relationships (Figure 6). These relationships lead to cascading changes so that updates made to one table can lead to updates made to all tables. This is usually a seamless and useful function of this type of database. For example, if a species name changes, a single change in the table "luCRIMPSpeciesList" will cascade the new name in all tables where that name is present. This can also lead to some unintended systematic errors. Therefore, it is important to be aware that these links exist.

Two tables are particularly important links for most tables throughout Tidebase: "luCRIMPSpeciesList" and "tblDailyFieldLog". The main species list, "luCRIMPSpeciesList", is the official species list for CRIMP and serves to define which species are required for each plot type, order the species to ease data entry, create a record of taxonomic lumping categories for reports, create official links to the MARINe database, and provide an opportunity to include comments. The Daily Field Log table, "tblDailyFieldLog" not only stores the data from the Daily Field Log for a given date, but also serves as the central table linking all of the data collected for that date to a single record. This table is where the individual dates are linked to a sampling season. These two tables, along with two additional tables, "luSiteList" and "luPersonnelList", serve as important keys to expand and interpret the rest of the tables in Tidebase, and will often need to be included in queries and reports.

Workflow

When Tidebase is opened, a switchboard automatically opens (Figure 7); this switchboard can be used to navigate through three main functions of Tidebase, data entry, data query, and entry into MARINe. For more sophisticated data analysis, the regular tools of MS Access should be used. The data entry function of Tidebase will be covered in the next few sections. The data query function is a set of buttons that runs some simple queries that allows the casual user to look up data. These queries can be sorted or exported to MS Excel ("File">"Export") but the data cannot be edited. As they are relatively simple to use, the data query buttons will not be covered further in this protocol. The MARINe integration functions will be covered in the MARINe Integration section. This switchboard should help the beginning user navigate easily through Tidebase. If the switchboard is accidentally closed, it can be reopened by going to the main window of the database, "Form">"Form: Main Switchboard".

To enter data, begin by pressing the "Enter Data" button on the switchboard (Figure 7). The sheet that opens is the main data entry form (Figure 8). The form is built so that the Daily Field Log logsheet is entered first for a given date, and the rest of the data is entered on subforms linked to that date. It is recommended to enter the data from all of the Daily Field Logs from all of the days of given season first, and then add the data from the rest of the plots, transects, and observations.

Once data are entered, there are a number of ways to scroll among sampling dates. At the very bottom of the window that says *Record:* with a set of triangles that will scroll through the dates either one at a time or to the beginning or the end (note that each subform has its own set of triangles as well). The scroll wheel on the mouse will also lead through the dates. There is a dropdown menu at the top of the form (*Find Date*) that can be used to search for dates. Please note that the date listed in the box above is not necessarily the date of the form; the date under *Date of Sampling:* and in the grayed out boxes in the subforms is the actual date that the form is set to.

See the specific sections below for instructions on entering data for each specific type of data.

Entering Personnel

Throughout Tidebase, there are fields where people's names need to be entered. All CRIMP participants have a 2-3 character unique code that is used to identify them. When asked to enter a name, there will be a corresponding drop-down box with the list of codes and names. If the name has not already been entered, press the *Enter New Personnel* button at the top of the form. This will open a new form where the name can be added. Begin by adding a new 3-character *Unique Code* (can include letters and number). Use the drop-down box to check if the code has been used before. If the code is not unique, an error box will come up (if this becomes bothersome and the errors won't stop, hit "esc" until the record is reset). It is suggested to use the persons first and second initials, followed by a sequential number, unless it is a frequent participant. Then enter the *Last Name* and *First Name*. The *Association* gives an indication of how the person is associated with CRIMP. In most cases, the participant is a Volunteer in Parks (VIP) or works for Cabrillo (CABR). It is acceptable to enter "Unknown" for legacy data. If the association has not already been entered into Tidebase, press the *Enter New Association* button to add the association. Comments can be added about a person in the *Comments (optional)* memo box.

Once the information about the participant has been added, press the *Close and Return to Field Log* button. This should refresh the data entry form so that the new person is listed on the drop-down list. If recently-entered names do not appear on the list, go to "Records">"Refresh". Try again. If this doesn't work, close the form and open it again. The name should now appear.

Daily Field Log

The main Tidebase data entry form is modeled off of the Daily Field Log logsheet. When the form is opened it should automatically go to a new record. If not, press the *Add a new date* button at the top of the form. Begin by entering your personnel code under *Entered By* (throughout the database, *Entered By* refers to the person entering the data into Tidebase) and the *Date of Sampling*; the data entry date is automatically entered into the table. Then enter the code of the *Person who filled out the field log* and the code for the sampling *Event* (season and year, i.e. SP for spring, FA for fall, and last two numbers of the year). The sampling events have been entered through 2011 for spring and fall. If more need to be added, go to the table "luEventList" and be sure to use the MARINe table ("luList03_MARINECommonSeason", a hidden table in the MARINe database) to get the appropriate order of seasons.

Continue to fill in the rest of the blanks. Times should be in 24:00 format and dates should be in mm/dd/yyyy format. The weather and sea conditions need to be filled in using specific codes listed in drop-down menus. *Water Temperature* can be either a code or a specific number, including a unit. The text boxes (*General Account of Work*, *Plot Repair Notes*, *Physical Observations*, *Biological Observations*) are all unlimited in size.

The *Participants* are filled in a separate subform on the left. Be sure to include the person who filled in the Daily Field Log as a participant as well. The subform will continue to lengthen as names are added so that all names will fit. When the form is refreshed, these names will automatically alphabetize.

Below the marine mammal data entry area, there is an area where *Data Entry Notes* can be added. It might be necessary to scroll down to reach this part of the form. These comments should be specific to data entry issues for that specific date or that season.

Once the Daily Field Logs are entered for all of the dates for a sampling season, move on to the rest of the data types, which can be found on the series of tabs below the Data Entry *Comments* box (Figure 8). It is necessary to have a Daily Field Log for a certain date before other data can be entered for that date. As mentioned above, all data is linked to a specific date rather than to the whole season. This is why a Daily Field Log must be completed for a date before any other data can be entered.

Zone Observations and Site Reconnaissance

Zone Observations

Data from the "Seasonal Observations for a Single Zone" logsheet are entered in the *Zone Observations* tab. Check that you are on the right date. Do NOT look at the *Find Date* box at the very top of the whole form. The gray box at the top of the form that simply says *Date* is the actual date where these data will be entered.

Tab through the various fields to enter the data. Use the drop-down menus to find the various codes. If there are specific comments about the data entry process for this zone

and date, use the *Entry Comments* box at the bottom. There should be one Zone Observation for each zone for each season.

When all data are entered for a zone for a season, you can either press the *Add another record for this date* button to get to a blank record for this date, scroll to another date to add another record for another zone and date, or switch to another plot type for this date.

Site Reconnaissance

Data from the "Site-Wide Species Conditions" logsheet are entered in the *Site Recon* tab. Check that you are on the right date. Do NOT look at the *Find Date* box at the very top of the whole form. The gray box at the top of the form that simply says *Date* is the actual date where these data will be entered.

Record the *Zone*, *Recorder*, and *Entered By* personnel codes at the top of the subform. If there is more than one recorder, use the most experienced recorder and list the other recorders in the *Comments* field, which can be used to record comments for the whole site recon for that date and zone.

It is important to include an entry for every species that was looked for, but not found for this technique. Tidebase has an automated routine to add "ND" (no data) for all of the species on the Site Recon logsheet. Once *Zone*, *Recorder*, and *Entered By* are added, make a note of the *Recon ID:*, the number in the gray box. Press the *Add Site Recon for this Zone* button. There will be a warning box saying that you will be running an append query; hit "Yes". Then enter the *Recon ID* when prompted. Again, you will be warned that you are about to append your data; hit "Yes". At this point, the table should fill in with a list of all of the species from the logsheet with "ND" for all of the data. Go through the table changing the NDs to the actual data from the logsheet. Comments for individual species can be added under the *Notes* column.

If there are additional species listed on the datasheet, do not add them to the table; add the observations to the general *Comments* at the bottom of the subform. It is possible to add species to the Site Recon list so that it is entered in to the table. This should be done with careful consideration and consultation with MARINe. If the species is already on the official CRIMP species list, it can be added to the Site Recon list by going to the table "luCRIMPSpeciesList", looking for the species, and clicking on the box under the "Recon" column in the appropriate row for the species. If the species is not already on the list it can be added, but it must be associated with a "MARINeOriginalName". See the MARINe Integration section for more information. Additional species should only be added to the table if they are to be included in the Site Recon in perpetuity. They must also be added to the Site Reconnaissance logsheet.

Lottia Data (Circular Plots)

Check that you are on the right date. Do NOT look at the *Find Date* box at the very top of the whole form. The gray box at the top of the form that simply says *Date* is the actual date where these data will be entered.

Enter the *Site ID* using the drop-down menu that includes the Zone and Plot Numbers; to double check that the correct site number has been entered, the corresponding *Zone* and *Plot ID* are shown in gray below the *Site ID*. The personnel code of the person entering the data and the recorder for the specific plot should be entered in the appropriate boxes towards the top of the subforms. Enter the *Measurer(s)* in the sub-subform on the left. This area will continue to expand and an unlimited number of measurers can be entered. Comments for the plot can be added in the *Comments* box at the bottom of the subform.

In order to enter the Lottia data use the table on the right. Enter the size under the *Size (mm)* column and the number of limpets under the *Number* column. Rows will continue to be added to the table as data is added. Continue until all of the data are entered.

Check the entered data. First, note the *Lottia/Date ID* listed in the gray box at the top of the subform next to the date. Then press the *Check lottia totals* button. Look for the *Lottia/Date ID* and check that the *CountOfSize* (sum of the number of size classes, easily determined by counting on the logsheet) and *SumOfNumber* (total number of limpets measured) are correct. Most errors are quickly caught by checking these totals. If the numbers are incorrect, close the query and fix the mistake on the form. If the numbers are correct, close the query and press the *Check lottia data* button. When prompted enter the Lottia/Date ID. A query with all of the data from the plot will run. Check all of the data carefully.

Once all of the data for the plot are entered and checked, it is possible to add another plot for that date by pressing the *Add another plot for this date*. Alternatively, circular plots for other dates can be added by scrolling through the dates or data for other plot types can be added by using the subform tabs.

Photoplot Info and Data

The data for photoplots are entered in two parts: the information about the photos is entered in the *Photo Info* tab and the actual data in the *Photoplot Data* tab.

Photo Info

This tab is used to enter field notes about the photographs such as: *Date photo taken*, *Photographer*, and any additional information that is associated with it. The form is designed to make the entry more efficient by automatically entering a full list of slides for a single date, which can then be edited individually to match the actual conditions.

First, make sure that you know the personnel code for the photographer and for you, the data entry person. Check that you are on the right date. Do NOT look at the *Find Date* box at the very top of the whole form. The gray box at the top of the form that says *Date Photograph Taken* is the actual date where these data will be entered. Press the *Add new photo day* button. When asked if you would like to run an append query, hit "Yes". Then enter the date when most of the photographs were taken, in the format mm/dd/yyyy. It is unlikely that all photos are taken on the same day; select the date when the most photos were taken. Then enter the personnel code of the photographer for most of the photos

and your personnel code. When asked to append data, hit "Yes". You should now see a complete list of plots in the table in the subform.

Now go through each plot correcting the actual date, *Photographer*, *Camera*, and adding *Comments* where appropriate. Rows can be deleted or added if necessary. Photo info can be entered before the photographs are scored.

Photo Data

Photoplot data for a given photoplot for a given date can not be entered until the *Photo Info* has been added. Once the photo is scored, data are entered in the *Photoplot Data* tab. Make sure you are on the correct date (the date that the photograph was taken, not the date the photo was scored) by checking the gray box in the upper left of the subform. Then use the arrow buttons at the upper left of the subform to scroll to the plot of interest. If you are unsure which date the photograph was taken, use the *Photo Info* tab as a reference. Once you are on the correct plot and correct date, enter *Photo scored by*, *Date photo scored*, and any additional comments for the plot (the *Comment* box should already include comments from when the photo was taken—there is a single shared box for photo taking and photo scoring comments).

It is important that all species that were actually looked for are listed in the database; if a species was looked for, but not found, a "0" should be entered for that species. Tidebase has an automated system to enter "0s" for all species listed on the Photoplot Data Sheet, which are all species that are required for photoplots under CRIMP. Once the basic information is entered as described above, press the *Add new photoplot* button. When asked if you would like to run an append query, hit "Yes". Then enter the *Photoplot/Date ID*, found in the gray box next to the button. Then hit "Yes" when prompted if you would like to append records. You will now see a complete list of species, in table format, with "0s" listed as the number of points. This list should match the order of the Photoplot Data logsheet, although sometimes the order is shifted so be careful when entering the data. At this point, you should scroll through and enter the data for each species.

Once the data are entered, they must be checked. Note the *Photoplot/Date ID*, and press the *Check Photoplot Totals* button. Look for the plot you just entered. The total should add to 100. This is an easy way to check for errors. If there is an error, close the query and correct the error in the subform. If the data are correct, close the query and press the *Check Photoplot Data* button. Carefully check the data.

Once all of the data for the plot are entered and checked, it possible to add another plot for that date scrolling to the plot of interest. Alternatively, photoplots for other dates can be added by scrolling through the dates or data for other plot types can be added by using the subform tabs.

Line Transects

Like photoplots, it is important to add "0s" for all species that were looked for, but not found while doing line transects. In this case, the zeros are added after all of the data have

been entered rather than before. Check that you are on the right date. Do NOT look at the *Find Date* box at the very top of the whole form. The gray box at the top of the form that simply says *Date* is the actual date where these data will be entered. Enter the *Site ID* (check using the reference *Zone* and *Plot* numbers in gray below it), *Recorder*, and *Entered by* fields. Enter all of the *Transect Readers*; this subform will continue to expand to accept an unlimited number of names. Comments for the transect can be put in the *Comments* box.

Once the information about the transect is added, add the transect data in the table. Use the codes under the *Category* column, followed by the *Start* point and the *End* point. Start recording at 10 mm, even if the logsheet begins at 0 mm (i.e. ignore 0-10 mm). If a cover is only found at one point, make the start and end the same. Do not overlap points. Use the start and end number plus 1 for surfgrass understory. If someone writes in extra information (such as species that are not included in the list) include it in the comments section. These rules are briefly demonstrated below:

LOGSHEET INFORMATION	
cm	Code
0	BK
10	SG
20	
30	
40	
50	
60	
70	
80	
90	BK/SGU
100	H/SGU
110	H
120	Large Snail
130	BK/SGU
140	SG
150	
160	

DATA ENTRY TRANSLATION		
Category	Start (cm)	End (cm)
SG	10	80
BK	90	90
H	100	110
SGU	91	101
OI	120	120
BK	130	130
SGU	131	131
SG	140	160
Comments: OI at 120 was scored as "Large Snail", no species was noted, and proper code was not used.		

Once all of the transect data have been entered, check them very carefully. At this point, you need to add zeros for all categories that are not present so far. Note the *Transect/Date ID* on the right side of the subform. Press the *Add zeros to data* button, hit "Yes" at the append query warning, enter the *Transect/Date ID*, and hit "Yes" at the second append warning. You will not see anything change yet. Then press the *See totals by taxa* button and enter the *Transect/Date ID*. Now you should see a complete list of taxa from the logsheet, including the total number of points found of each category. Look at these data and see if they make sense. Then close the query and press the *See total for transect*

button. The total number of points for the transect should be 100 plus the number of points of surfgrass understory.

Once the data are entered and checked, it is CRUCIAL that you press the last button—*To finish, press this button to add the data!!* Up to this point, the data have been stored in a holding table (xxxEnterTransects) and have not been added to the actual database. You must press this button and complete the steps to add the transect data to the database.

Be sure to add the observational data for the grass (*Smithora*, *Melobesia*, etc.) in the appropriate sub-subform at the bottom.

Timed Search

Since timed search data is fundamentally presence/absence data, it is crucial that "0s" are included in Tidebase for all species that were searched for during the timed search. Tidebase has been built with an automated function to create zeros for all species on the Timed Search logsheet.

Check that you are on the right date. Do NOT look at the *Find Date* box at the very top of the whole form. The gray box at the top of the form that simply says *Date* is the actual date where these data will be entered. Enter the *Zone*, the *Recorder*, and the person who is entering the data. If there are multiple recorders, enter the most experienced recorder and include additional recorders in the *Comments* field. Comments about the search in general (including area searched and times) can also be included in the *Comments* field. Then note the *Search ID* in the gray box above the central table. Press the button *Create new timed search*, and hit "Yes" when asked to run an append query. Enter the *Timed Search ID*, and hit "Yes" again to add the data. You should now see a complete list of species (scientific names) from the logsheet, with "0s" listed next to them, in the table.

You can now go through and change the "0s" to the actual data, if appropriate, and add specific notes about each species in the *Notes* column. If a species was not specifically searched for, delete the whole row, but be sure to make a note in the *Comments* box that the species was specifically not looked for.

If there are additional species on the logsheet, do not add them at the bottom of the table; simply transcribe the observation into the *Comments* box at the bottom of the form. It is possible to add species to the timed search. This should be done with careful consideration and consultation with MARINe. If the species is already on the official CRIMP species list, it can be added to the timed search list by going to the table "luCRIMPSpeciesList", looking for the species, and clicking on the box under the "Timed Search" column in the appropriate row for the species. If the species is not already on the list, it can be added, but it must be associated with a "MARINeOriginalName". See the MARINe Integration section for more information. Additional species should only be added to the table if they are to be searched for in perpetuity. They must also be added to the Timed Search logsheet and pictorial guide (Appendix E).

Data Entry Tips and Common Errors

Helpful Data Entry Tips

Below are some helpful hints will improve your efficiency while entering data into Tidebase:

- MS Access automatically saves records as they are completed, even if you do not press "Save". Once you start entering a record, a pencil icon  will appear on the side of the form; the record is in edit mode and has not yet been saved. Once you are finished, and the pencil returns to a triangle  , the record has been saved. Changes are made automatically, so do not assume that your edits are temporary.
- While you are editing a record (and the pencil icon is present), you can completely undo your changes by hitting Esc. Often, you will need to hit Esc multiple times to start the record over. This comes in handy when an error occurs and error messages keep popping up. Just stop and hit Esc until the record clears.
- Use tabs to move through the different fields on the forms. Most forms have been designed so that the tab order follows the appropriate work flow. Use shift-tab to move backwards. It is much faster to enter data without lifting your hand from the keyboard to use the mouse.
- Use F4 to reveal drop-down lists without using the mouse.
- Use shift-F2 to open a "Zoom Box", a bigger text box for entering longer strings of text.
- Look at the bottom gray bar of the form—there is often a text message when selected within a field that explains more about the field.
- If you learn more about MS Access, it is handy to create default values for certain fields that are very consistent through time. For example, if one person does all of the data entry, you can make their personnel code the default value for the *Entered By* field for all of the tables. This is done by going to the design view of the tables, and entering their code in quotes under *Default Value*. Other fields that are good candidates for default values: photoplot *Photographer* and *Photo Scored By*.

An Important Word of Caution

Keep in mind that it is very easy to make unintentional changes to Tidebase. Always archive the database before making any structural changes (see Data Archiving and Compaction section), and always experiment on copies, not on the working version.

Common Errors

Here are some common MS Access errors and what they mean.

- *"The text you entered isn't an item in the list"*

You tried to enter something into a field that is limited to a specific list of entries. There is probably a drop-down menu with a list of the options for that field. Look for a field with a drop-down menu and choose one of the options from the list.

- *"The field 'add field here' cannot contain a Null value because the Required property for this field is set to True. Enter a value in this field."*

There are some fields that are required, like a date, a plot, a recorder, etc. If you try to skip that field, you might get this error. Enter a value. These are usually things that are pretty crucial, and will not be missing. If you have a logsheet where you know the season, but you do not know the date, you can use a false date and note in the comments what you have done.

- *"The changes you requested to the table were not successful because they would create duplicate values in the index, primary key, or relationship"*

There are some fields (or combination of fields) where you cannot have repeats. The data you just entered were rejected because something you entered has been entered before. The most common cases where this error comes up are:

  - Personnel codes: this is sort of pain, as this system is pretty clunky. Keep choosing personnel codes until you find one that is unique. The drop-down menu should list the codes that are already taken. If you think that you've found a code that is unique, it could be that the name is already taken. You might need to enter something like "John Smith2" or "John Q. Smith" and include in comments something about who your John Smith is so that someone can tell the two apart. We've gotten away without having name repetition, but it could happen.
  - The data for a plot has already been entered for that year. Go to the "See Data" queries and check that the data already in Tidebase are correct. Perhaps someone entered data for past years incorrectly and they appear to be from your season?

- *"You can't save this record at this time"*

If you hit an error while entering one of your records, you get a chance to fix it. If you get the error again, and you are struggling to fix it, you can try to hit Esc to start over. Or you might try to just close the form. After a few error messages, you might get this error message. This basically means that Access is giving up on this record. It's basically deleting the record and letting you start over.

Data Archiving and Compaction

Since it is very easy to make unintentional changes to Tidebase, it is crucial to archive the database often. The file should be archived after the data has been entered from every sampling season, and before any structural changes are made to the database. At the same time, there must only be a SINGLE WORKING COPY of the database at any given time, so that data are not being entered into multiple databases. The following set of archiving rules should be enforced:

- The working version of the database is called "tidebase.mdb". No other file should be called tidebase. Copies on other computers must have a different name. Tidebase is currently (as of June 2006) being stored in J:\Data\intertidal\NRSDatabases\Tidebase.
- When all of the data for a season has been entered, or before a structural change is made to the database, a copy of the database should be added to an archival zip file called tidebase.zip. As of May 2006, this archival file was stored in

J:\Data\intertidal\NRSDatabases\Database Archives. The copy of the database should be renamed "Copy of Tidebase yyyy_mm_dd.mdb" (where y=year, m=month, and d=day), before being put in the database.

- In addition, the J:\ drive and current tidebase file should be backed up regularly as part of good NPS data backup practices.
- Immediately after archiving tidebase, the current version should be compacted. This is done by going to "Tools">"Database Utililties" >"Compact and Repair Database"

Regularly compacting the database will ensure its long-term integrity.

MARINe Integration

Tidebase was built to minimize redundancy in entering data twice, once in Tidebase and once in MARINe. If for some reason, data needs to be entered directly into MARINe, see Bealer and Copper (2003). In addition, see the internal webpage, accessible through a portal at www.marine.gov. Contact Jack Engle (j_engle@lifesci.ucsb.edu, 805-893-8547) for the internal password and Larry Cooper (larryc@sccwrp.org) for more information or with questions about the database.

Overview—MARINe Database

The MARINe database consists of past, present, and future data, from many different rocky intertidal monitoring groups throughout the west coast of the United States. In its construction, there were a number of compromises made to fit this very challenging logistical situation. Tidebase v.2 was then designed to integrate with MARINe to maximize the efficiency between them while minimizing data loss and potential for errors.

The main working version of the complete database resides at SCCWRP (the Southern California Coastal Water Research Project Authority, www.sccwrp.org). On a fairly regular basis, SCCWRP will send out updates of copies of the database file to the members. These local copies are not networked and are only current from the time that they have been sent. In addition to these updates of the complete database, SCCWRP also sends each MARINe group a copy of a data entry file of MARINe that is specific to the group. In the case of CABR, this file contains only the CABR data including all of the CABR data that has been entered into the main working version as of the time the data entry file was released. All data that is entered into the actual database has two flags.

When new versions of the two local files are released, they are usually downloadable from the internal MARINe webpage. Usually, the downloaded file is in .zip format. Remove the old zip files and store them as archives in J:\Data\intertidal\NRSDatabases\MARINE database\MARINe Database Archive\Old Zip Files. Store the old database file in J:\Data\intertidal\NRSDatabases\MARINE database\MARINe Database Archive/MARINe Database Archive.zip. Put the most current version of the two zip files in J:\Data\intertidal\NRSDatabases\MARINE database\Current Versions. Unzip the main database file and store the .mdb file with the current zip files in the Current Versions file. Unzip the data entry file and store it in the same folder as tidebase, J:\Data\intertidal\NRSDatabases\Tidebase. Be sure to archive the old data entry .mdb file in

J:\Data\intertidal\NRSDatabases\MARINE database\MARINe Database Archive\MARINe CABR Data Entry Archive.zip. When archiving the .mdb files, use the same general procedure as when archiving tidebase described in the Data Archiving and Compacting section above.

At CABR, new data are entered into this new MARINe data entry file, either manually or automatically through Tidebase; these new data are flagged as being new. Once the data for a season are entered, the MARINe database has an automated function to compile all of the newly added data into a single, smaller database of just the new data. This smaller database is emailed to the people at SCCWRP, who then input the new data into the main working version of MARINe. Therefore, the local copy of the whole database housed at CABR does NOT contain recent data from CABR or other MARINe groups until a new updated version is sent out by SCCWRP.

Tidebase and MARINe Links

Be sure that you have the most recent version of the MARINe data entry database for CABR (check the MARINe internal webpage), that it is unzipped and the .mdb file is in the same folder as Tidebase. Make sure that the links between Tidebase and MARINe are current. Go to "Tools"> "Database Utilities" > "Linked Table Manager" and "Select All", and then press "OK". If there has been a change in the name or location of the MARINe data entry database, you will now have an opportunity to point Tidebase to the right file. As long as the names of the tables within MARINe have not changed, the links should reconnect. If SCCWRP makes changes to the names of the tables or fields within the table, you might need to go into the guts of the links to reconnect them. This should be done by someone who has knowledge of Access.

Species List Coordination

Keeping the CRIMP and MARINe species lists coordinated represents the greatest challenge of the database integration process. This has been achieved in Tidebase using three separate tables.

- "luCRIMPSpeciesList" is the official CRIMP species list. The *Species/Category* is the CRIMP name for a given taxa, and the *MARINeOriginalName* is the taxa it will link to in the MARINe database.
- "luOfficialSpeciesListImported" is the official MARINe species list. This list has been IMPORTED from MARINe. This means that it was taken from MARINe and actually put into Tidebase with no live connection. Think of this as a "copy and paste". This table does not automatically update from MARINe, as it is now actually a part of Tidebase. The *MARINeOriginalName* field of this table is what is linked with "luCRIMPSpeciesList".
- "mluOfficialSpeciesList" is also the official MARINe species list, but it is LINKED to the MARINe database. This table will automatically update from MARINe, as long as the link is kept updated (see Tidebase and MARINe Links section above). Over time, this table can change, while the imported table will not change unless it is manually changed. This table is NOT linked to the CRIMP Species List.

The goal is to keep "luCRIMPSpeciesList" updated with the information in "mluOfficialSpeciesList", but these two tables cannot automatically update. If MARINe makes a change to the species list, "mluOfficialSpeciesList" will change, but "luOfficialSpeciesListImported" will not. Therefore, every time a new MARINe data entry database is released, compare the LINKED and IMPORTED tables. They need to be identical. If there are differences between the two tables, and they are relatively minor, you can make careful manual alterations to the imported table. If there are many large changes, then re-import the species list. Make a copy of the database before you make this change, in case there is a problem. Go to "File" > "Get External Data" > "Import" and select the MARINe data entry .mdb file. Select the table "luOfficialSpeciesList". Change its name to "luOfficialSpeciesListImported" and replace the old file (delete its relationships, when prompted). Open the relationships window ("Tools" >"Relationships"). Add the newly imported table ("Relationships" > "Add Table" > "luOfficialSpeciesListImported"). Drag the window for the newly imported table to the window for "luCRIMPSpeciesList". Put the cursor on *OriginalName* from the imported table, and drag it to the *MARINeOrgiginalName* field on the "luCRIMPSpecieList" table. Click on the boxes "Enforce Referential Integrity" and "Cascade Update Related Fields". If you get an error while making this relationship, it is possible that you have added a *MARINeOriginalName* to the CRIMP species list that is not on the MARINe Species list. Review the CRIMP and MARINe lists, and make CRIMP consistent with the MARINe list. That is the purpose of this link.

Adding Data to MARINe

Once the two databases and species lists are linked, transferring data from Tidebase to MARINe is relatively easy. From the main Tidebase switchboard, press the *Add to MARINe* button. Another switchboard comes up. On the left is a series of buttons that allows you to check the format of the data. When you press these buttons, you will be prompted to enter the season (e.g. SP06 for spring 2006), and you will see a query of the table that will be entered into MARINe for a given plot type. The buttons on the right will run the same queries, but will actually append the data into the MARINe data entry database. It is required to enter the Daily Field Log for a season first. You can only enter data one season at a time. Make sure you have pressed the right hand button for all plot types for the season.

Once you have entered the data into MARINe, you still need to go into the MARINe data entry database to actually send the data to SCCWRP. Close Tidebase and open the MARINe data entry database. The main MARINe switchboard should automatically open. On the right hand side, under "Utility", press the button that says *Send Data*. It will take a few minutes to compile the data. At the end you should get a message with the name and location of a file. You should find that file and email it immediately to Larry Cooper and Bruce Bealer at SCCWRP (larryc@sccwrp.org, bruceb@sccwrp.org). Ask them to confirm that it has loaded. Archive the file to J:\Data\intertidal\NRSDatabases\MARINE database\Submitted Data and Changes.

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Table 1: CRIMP Species List. Includes which taxa are required for which plot types, and the species that links between Tidebase and the MARINe database.

CRIMP Species/Category	Photoplots Required	Photoplots Optional	Transects Required	Transect Code	Reconnaissance Required	Timed Search Required	MARINe Linked Name	Comments
Anthopleura elegantissima/sola	X		X	A	X		anthopleura elegantissima/sola	
Articulated corallines	X		X	AC			articulated corallines	
Articulated corallines on *Mytilus californianus*	X						mytilus californianus	
Asterina miniata						X		Not in MARINe Species List, but is on timed search list. Does not export to MARINe.
Astrometis sertulifera						X		Not in MARINe Species List, but is on timed search list. Does not export to MARINe.
Byssal threads on rock		X					rock	This was added in SP06 for use in Zone I M6, a plot added to track the damage from a boat crash in January 2006. This will link with rock for MARINe, but might come in handy when tracking the recovery.
Caulacanthus ustulatus					X		caulacanthus ustulatus	
Chitons	X						chitons	
Chondracanthus canaliculatus	X				X		chondracanthus canaliculatus	
Chthamalus dalli/fissus/Balanus glandula	X		X	B			chthamalus dalli/fissus/balanus glandula	
Chthamalus spp/*Balanus glandula*					X		chthamalus dalli/fissus/balanus glandula	
Chthamalus spp/*Balanus glandula* on *Mytilus californianus*	X						mytilus californianus	
Chthamalus spp/*Balanus glandula* on *Tetraclita rubescens*	X						tetraclita rubescens	
Cladophora columbiana	X				X		cladophora columbiana	
Colpomenia spp			X	CO			colpomenia spp	
Crustose corallines	X		X	CC			crustose corallines	
Egregia menziesii	X		X	BK	X		egregia menziesii	
Eisenia arborea	X		X	SP	X		eisenia arborea	
Endarachne binghamiae/Petalonia fascia	X						endarachne binghamiae/petalonia fascia	
Endarachne/Petalonia					X		endarachne binghamiae/petalonia fascia	

CRIMP Species/Category	Photoplots Required	Photoplots Optional	Transects Required	Transect Code	Reconnaissance Required	Timed Search Required	MARINe Linked Name	Comments
Enderachne binghamiae/Petalonia fascia on *Mytilus californianus*	X						mytilus californianus	
Enderachne binghamiae/Petalonia fascia on *Tetraclita rubescens*	X						tetraclita rubescens	
Endocladia muricata	X				X		endocladia muricata	
Fucus gardneri	X				X		fucus gardneri	
Halidrys dioica/Cystoseira spp	X		X	H	X		halidrys dioica/cystoseira spp	
Haliotis corrugata						X		Not in MARINe Species List, but is on timed search list. Does not export to MARINe.
Haliotis cracherodii					X	X	haliotis cracherodii	
Haliotis fulgens						X		Not in MARINe Species List, but is on timed search list. Does not export to MARINe.
Hesperophycus californicus	X				X		hesperophycus californicus	
Ligia occidentalis					X		ligia occidentalis	
Limpets	X						limpets	
Limpets on *Mytilus californianus*	X						mytilus californianus	
Littorina spp					X		littorina spp	
Lottia gigantea	X				X		lottia gigantea	
Mastocarpus papillatus	X				X		mastocarpus papillatus	
Mazzaella affinis	X				X		mazzaella affinis	
Mazzaella spp (=*Iridaea* spp)		X			X		mazzaella spp (=iridaea spp)	
Mexacanthina lugubris	X				X		mexacanthina lugubris	
Mytilus californianus	X		X	M	X		mytilus californianus	
Non-coralline crusts	X		X	NC			non-coralline crusts	
Other barnacle	X						other barnacle	
Other brown algae	X		X	OB			other brown algae	
Other green algae	X		X	OG			other green algae	
Other invertebrates	X		X	OI			other invertebrates	
Other plants/algae	X		X	OP			other plants/algae	
Other red algae	X		X	OR			other red algae	
Other red algae on *Lottia gigantea*		X					lottia gigantea	
Other red algae on *Mytilus californianus*	X						mytilus californianus	

CRIMP Species/Category	Photoplots Required	Photoplots Optional	Transects Required	Transect Code	Reconnaissance Required	Timed Search Required	MARINe Linked Name	Comments
Other red algae on *Pollicipes polymerus*	X						pollicipes polymerus	
Other red algae on *Tetraclita rubescens*	X						tetraclita rubescens	
Other substrate		X					other substrate	
Pelvetiopsis limitata	X				X		pelvetiopsis limitata	
Phragmatopoma californica	X		X	SW	X		phragmatopoma californica	
Phyllospadix scouleri/torreyi	X				X		phyllospadix scouleri/torreyi	
Phyllospadix scouleri/torreyi overstory			X	SG			phyllospadix scouleri/torreyi overstory	
Phyllospadix scouleri/torreyi understory			X	SGU			phyllospadix scouleri/torreyi understory	
Pisaster giganteus						X		Not in MARINe Species List, but is on timed search list. Does not export to MARINe.
Pisaster ochraceus	X				X	X	pisaster ochraceus	
Pollicipes polymerus	X				X		pollicipes polymerus	
Porphyra spp	X				X		porphyra spp	
Postelsia palmaeformis					X		postelsia palmaeformis	
Rock	X		X	R			rock	
Sand	X		X	SA			sand	
Sargassum muticum	X		X	S	X		sargassum muticum	
Scytosiphon spp	X				X		scytosiphon spp	
Silvetia compressa	X				X		silvetia compressa	
Silvetia compressa on *Mytilus californianus*	X						silvetia compressa	
Strongylocentrotus franciscanus						X		Not in MARINe Species List, but is on timed search list. Does not export to MARINe.
Strongylocentrotus purpuratus					X	X	strongylocentrotus purpuratus	
Tar	X		X	T	X		tar	
Tegula spp					X		tegula spp	
Tetraclita rubescens	X				X		tetraclita rubescens	
Tetraclita rubescens on *lottia gigantea*		X					lottia gigantea	
Tetraclita rubescens on *Mytilus californianus*	X						mytilus californianus	
Ulva spp/*Enteromorpha* spp	X						ulva spp/enteromorpha spp	
Ulva/Enteromorpha					X		ulva spp/enteromorpha spp	
Unidentified	X		X	UI			unidentified	

CRIMP Species/Category	Photoplots Required	Photoplots Optional	Transects Required	Transect Code	Reconnaissance Required	Timed Search Required	MARINe Linked Name	Comments
Unscorable	X						unscorable	
Unscorable-drift algae	X						unscorable	Just for CRIMP records, will sort out as unscorable for MARINe data.
Unscorable-off rock edge	X						unscorable	Just for CRIMP records, will sort out as unscorable for MARINe data.
Unscorable-shadow	X						unscorable	Just for CRIMP records, will sort out as unscorable for MARINe data.
Unscorable-shoe	X						unscorable	Just for CRIMP records, will sort out as unscorable for MARINe data.

Table 2: List of Monitoring Techniques used in the Cabrillo National Monument Rocky Intertidal Monitoring Program. Target species are listed after the appropriate technique.

Technique/Taxa	Dimensions of Plot	Fixed Plot	Plot Code	Number per Zone	Type of Data
Circular Plots:	3.14 m^2	Yes		6	Size Frequency
Owl Limpets (*Lottia gigantea*)			L	(6, 8, 6)	
Photoplots:	50 x 75 cm	Yes		21	% Cover
Acorn and Thatched Barnacles (*Chthamalus dalli/fissus/Balanus glandula, Tetraclita rubescens*)			B	(5)	
Golden Rockweed (*Silvetia compressa*)			Pe	(5)	
California Mussels (*Mytilus californianus,* few *M. galloprovincialis*)			M	(6, 5, 5)	
Goose Barnacles (*Pollicipes polymerus*)			Po	(6)	
Line Transects:	10 m	Yes		6	% Cover
Red Algal Turf (mixed assemblage)			T	(2)	
Surf Grass (*Phyllospadix scouleri/torreyi*)			G	(2)	
Boa Kelp (*Egregia menziesii*)			K	(2)	
Timed Search	30 person-minutes	No		1	Presence/Absence
Black Abalone (*Haliotis cracherodii*)					
Ochre Sea Star (*Pisaster ochraceus*)					
Overview Photos	180°	Yes		4 (upper and lower)	Archival Photos
Whole Site			MOV		
Zone Observations and Reconnaissance	Whole Site	No		1	Standardized Observations
Various Core Species					

Table 3: Zone I Site List for the Cabrillo National Monument Rocky Intertidal Monitoring Program. ND=not determined, n/a=not applicable (measurement is an estimate), Std. Dev.=the standard deviation of the GPS measurements. Standard deviation of tidal height measurement is approximately 4 inches. Measurements for M6 were estimated from the recorded location of a mussel cage located near the plot during a 2005 experiment.

CRIMP Plots with Locations—Zone I								
Plot ID	Site ID	Plot Type	Target Species	Bolt	Lat. (°N)	Long. (°W)	Std. Dev.	Tidal Height (in above MLLW)
L1	280	Circular Plot	Owl Limpets		32.669477	-117.245499	n/a	61.47
L2	284	Circular Plot	Owl Limpets		32.669396	-117.245625	0.099864	52.22
L3	283	Circular Plot	Owl Limpets		32.669262	-117.245514	0.235812	51.22
L4	282	Circular Plot	Owl Limpets		32.66911	-117.245449	0.092904	65.22
L5	279	Circular Plot	Owl Limpets		32.669154	-117.24528	0.100069	56.72
L6	277	Circular Plot	Owl Limpets		32.669113	-117.245213	n/a	48.22
B1	286	Photoplot	Barnacles		32.669721	-117.245609	0.135574	30.47
B2	299	Photoplot	Barnacles		32.669621	-117.245614	0.116806	38.22
B3	294	Photoplot	Barnacles		32.669486	-117.245829	n/a	28.97
B4	292	Photoplot	Barnacles		32.669211	-117.245595	0.223629	27.72
B5	293	Photoplot	Barnacles		32.669166	-117.245532	0.067995	29.47
M1	298	Photoplot	Mussels		32.669525	-117.245838	n/a	38.47
M2	297	Photoplot	Mussels		32.669516	-117.245832	n/a	27.47
M3	296	Photoplot	Mussels		32.669365	-117.245836	n/a	25.97
M4	289	Photoplot	Mussels		32.669308	-117.245801	n/a	18.47
M5	285	Photoplot	Mussels		32.669291	-117.245657	n/a	31.22
M6	275	Photoplot	Mussels		32.66938	-117.24576	ND	15.88
Pe1	291	Photoplot	Rockweed		32.669444	-117.245619	0.150569	20.72
Pe2	290	Photoplot	Rockweed		32.669396	-117.245541	0.073069	31.72
Pe3	295	Photoplot	Rockweed		32.669334	-117.245551	0.110047	18.97
Pe4	288	Photoplot	Rockweed		32.669228	-117.245549	0.223704	24.47
Pe5	287	Photoplot	Rockweed		32.669194	-117.245424	0.133229	38.47
Po1	276N	Photoplot	Goose Barnacles		32.669617	-117.245517	0.121877	53.22
Po2	276C	Photoplot	Goose Barnacles		32.669573	-117.245522	0.521161	55.72
Po3	281N	Photoplot	Goose Barnacles		32.669293	-117.245373	0.170371	64.22
Po4	281S	Photoplot	Goose Barnacles		32.669219	-117.245355	0.139746	16.22
Po5	278N	Photoplot	Goose Barnacles		32.669139	-117.245216	0.112053	54.22
Po6	278S	Photoplot	Goose Barnacles		32.669116	-117.245204	0.098488	56.97
T1	237	Line Transect	Red Algal Turf	N	32.669761	-117.245583	0.304793	23.22
				C	32.669714	-117.245587	0.278975	ND
				S	32.66967	-117.24559	0.199365	19.22
T2	210	Line Transect	Red Algal Turf	N	32.669095	-117.245395	0.095701	14.47
				C	32.669055	-117.245368	0.131361	ND
				S	32.669022	-117.245342	0.189513	8.22
G3	238	Line Transect	Surfgrass	N	32.669669	-117.245651	n/a	14.97
				C	32.669628	-117.245635	n/a	ND
				S	32.669584	-117.245619	n/a	14.97
G4	211	Line Transect	Surfgrass	N	32.669037	-117.245238	n/a	-2.21
				C	32.668999	-117.245228	n/a	ND
				S	32.668959	-117.245217	n/a	10.22
K5	236	Line Transect	Boa Kelp	N	32.669636	-117.245798	n/a	3.22
				C	32.669591	-117.245809	n/a	ND
				S	32.669547	-117.245819	n/a	0.47
K6	212	Line Transect	Boa Kelp	N	32.669022	-117.245342	0.189513	8.22
				C	32.668985	-117.245312	n/a	ND
				S	32.66895	-117.245279	n/a	6.47

Table 4: Zone II Site List for the Cabrillo National Monument Rocky Intertidal Monitoring Program. ND=not determined, n/a=not applicable (measurement is an estimate), Std. Dev.=the standard deviation of the GPS measurements. Standard deviation of tidal height measurement is approximately 4 inches.

CRIMP Plots with Locations--Zone II								
Plot ID	Site ID	Plot Type	Target Species	Bolt	Lat. (°N)	Long. (°W)	Std. Dev.	Tidal Height (in above MLLW)
L1	239	Circular Plot	Owl Limpets		32.66819	-117.245128	0.120667	46.14
L2	243	Circular Plot	Owl Limpets		32.667736	-117.245068	n/a	43.64
L3	240	Circular Plot	Owl Limpets		32.667439	-117.245159	0.099441	38.39
L4	242	Circular Plot	Owl Limpets		32.667297	-117.244944	0.095125	29.98
L5	266	Circular Plot	Owl Limpets		32.667191	-117.24492	0.119911	42.26
L6	241	Circular Plot	Owl Limpets		32.667117	-117.24536	0.13157	29.64
L7	242A	Circular Plot	Owl Limpets		n/a	ND	n/a	48.26
L8	266A	Circular Plot	Owl Limpets		n/a	ND	n/a	70.26
B1	247	Photoplot	Barnacles		32.66793	-117.245276	0.098347	21.39
B2	248	Photoplot	Barnacles		32.667938	-117.24522	0.18427	33.14
B3	256	Photoplot	Barnacles		32.667326	-117.245159	0.144025	16.76
B4	259	Photoplot	Barnacles		32.667239	-117.245046	0.118495	16.92
B5	260	Photoplot	Barnacles		32.667113	-117.245055	0.080409	39.76
Po1	275N	Photoplot	Goose Barnacles		32.667895	-117.245014	0.148883	58.39
Po2	275C	Photoplot	Goose Barnacles		32.667881	-117.245016	0.094434	54.64
Po3	274N	Photoplot	Goose Barnacles		32.667235	-117.244918	0.182115	41.26
Po4	274S	Photoplot	Goose Barnacles		32.667157	-117.244922	0.094743	69.76
Po5	273N	Photoplot	Goose Barnacles		32.667049	-117.244838	0.163687	62.51
Po6	273S	Photoplot	Goose Barnacles		32.667007	-117.244824	0.141477	64.26
M1	245	Photoplot	Mussels		32.668002	-117.245313	0.074474	17.64
M2	246	Photoplot	Mussels		32.667916	-117.245302	0.081164	ND
M3	253	Photoplot	Mussels		32.66771	-117.245264	0.127676	22.64
M4	254	Photoplot	Mussels		32.667659	-117.245264	0.067801	23.39
M5	255	Photoplot	Mussels		32.667533	-117.245419	n/a	19.89
Pe1	249	Photoplot	Rockweed		32.667887	-117.245181	0.212161	6.64
Pe2	251	Photoplot	Rockweed		32.667863	-117.245207	0.147188	26.14
Pe3	252	Photoplot	Rockweed		32.6678	-117.245139	0.054098	14.39
Pe4	258	Photoplot	Rockweed		32.667253	-117.2451	0.080494	13.76
Pe5	265	Photoplot	Rockweed		32.667203	-117.24502	0.087944	15.59
T1	244	Line Transect	Red Algal Turf	N	32.668294	-117.245069	0.074744	2.14
				C	32.668251	-117.245063	0.097741	9.14
				S	32.668207	-117.245056	0.153475	15.14
T2	270	Line Transect	Red Algal Turf	N	32.667307	-117.245346	0.072159	5.39
				C	32.667261	-117.245331	0.114567	3.64
				S	32.667223	-117.245314	0.057492	4.89
G3	267	Line Transect	Surfgrass	N	32.668326	-117.245192	n/a	-4.87
				C	32.668281	-117.245188	n/a	ND
				S	32.668234	-117.245181	n/a	-3.37
G4	271	Line Transect	Surfgrass	N	32.667277	-117.245433	n/a	3.39
				C	32.667233	-117.245426	n/a	ND
				S	32.667187	-117.245418	n/a	3.14
K5	268	Line Transect	Boa Kelp	N	32.668323	-117.245207	n/a	-4.12
				C	32.668277	-117.245208	n/a	-4.37
				S	32.668232	-117.245208	n/a	-1.62
K6	272	Line Transect	Boa Kelp	N	32.667314	-117.245521	n/a	-0.87
				C	32.667275	-117.245496	n/a	ND
				S	32.667236	-117.245469	n/a	4.64

Table 5: Zone III Site List for the Cabrillo National Monument Rocky Intertidal Monitoring Program. ND=not determined, n/a=not applicable (measurement is an estimate), Std. Dev.=the standard deviation of the GPS measurements. Standard deviation of tidal height measurement is approximately 4 inches.

CRIMP Plots with Locations--Zone III								
Plot ID	Site ID	Plot Type	Target Species	Bolt	Lat. (°N)	Long. (°W)	Std. Dev.	Tidal Height (in above MLLW))
L1	13	Circular Plot	Owl Limpets		32.665286	-117.243425	0.172549	83.75
L2	26	Circular Plot	Owl Limpets		32.664493	-117.24267	0.114492	48.51
L3	21	Circular Plot	Owl Limpets		32.664446	-117.24261	0.155677	42.26
L4	19	Circular Plot	Owl Limpets		32.664412	-117.242608	0.101589	40.51
L5	18	Circular Plot	Owl Limpets		32.664365	-117.242586	0.13288	58.76
L6	11	Circular Plot	Owl Limpets		32.664326	-117.242424	0.157266	56.01
B1	3	Photoplot	Barnacles		32.66503	-117.243188	0.105446	32.00
B2	16	Photoplot	Barnacles		32.665011	-117.243177	0.125486	30.00
B3	29	Photoplot	Barnacles		32.66468	-117.242701	0.109777	49.01
B4	30	Photoplot	Barnacles		32.664664	-117.242703	0.092104	40.51
B5	20	Photoplot	Barnacles		32.66443	-117.242613	0.148332	44.26
Po1	269N	Photoplot	Goose Barnacles		32.665606	-117.243656	0.216137	64.00
Po2	269S	Photoplot	Goose Barnacles		32.66556	-117.243615	0.12321	91.75
Po3	196	Photoplot	Goose Barnacles		32.665383	-117.243462	0.455776	69.75
Po4	196S	Photoplot	Goose Barnacles		32.665349	-117.243461	0.444158	85.25
Po5	023N	Photoplot	Goose Barnacles		32.665038	-117.242851	0.265373	59.75
Po6	023S	Photoplot	Goose Barnacles		32.665024	-117.242858	0.044647	55.00
M1	24	Photoplot	Mussels		32.664445	-117.242618	0.204238	35.51
M2	15	Photoplot	Mussels		32.664407	-117.242596	0.070133	28.98
M3	14	Photoplot	Mussels		32.664389	-117.242589	0.159721	43.51
M4	17	Photoplot	Mussels		32.664328	-117.242507	0.147409	36.51
M5	12	Photoplot	Mussels		32.66432	-117.242489	0.076173	42.01
Pe1	9	Photoplot	Rockweed		32.664664	-117.242621	0.125812	29.26
Pe2	10	Photoplot	Rockweed		32.664683	-117.242576	0.171752	27.26
Pe3	28	Photoplot	Rockweed		32.664625	-117.242681	0.153146	24.01
Pe4	27	Photoplot	Rockweed		32.664624	-117.242656	0.100087	30.51
Pe5	25	Photoplot	Rockweed		32.664466	-117.242651	0.120529	25.26
T1	1	Line Transect	Red Algal Turf	N	32.665846	-117.244598	0.1341	40.00
				C	32.665808	-117.244576	0.10494	37.50
				S	32.665765	-117.24455	0.220791	29.25
T2	8	Line Transect	Red Algal Turf	N	32.665691	-117.244137	0.106055	31.75
				C	32.665645	-117.244123	0.071978	31.50
				S	32.665601	-117.244109	0.060929	29.50
G3	7	Line Transect	Surfgrass	N	32.665896	-117.244391	0.131219	30.25
				C	32.665869	-117.244432	n/a	27.00
				S	32.665843	-117.244473	0.128153	29.00
G4	5	Line Transect	Surfgrass	N	32.665821	-117.244485	0.154237	32.25
				C	32.665768	-117.244475	0.109003	29.00
				S	32.665733	-117.244476	0.119849	26.75
K5	2	Line Transect	Boa Kelp	N	32.665747	-117.244657	n/a	26.75
				C	32.665701	-117.244652	n/a	ND
				S	32.665657	-117.244646	n/a	24.75
K6	4	Line Transect	Boa Kelp	N	32.665567	-117.244624	n/a	4.73
				C	32.665526	-117.244641	n/a	4.23
				S	32.665481	-117.24466	n/a	1.23

Table 6: Checklist of Required Equipment for the Cabrillo National Monument Rocky Intertidal Monitoring Program. A. Complete list. B. By activity.

A.

Item	Comments
Logsheets	Photocopy (waterproof)
Volunteer paperwork	Photocopy
Flyer of volunteer opportunities	Photocopy
Volunteer primer	Photocopy
Paper maps (for timed search)	Photocopy (waterproof)
Plot guides	
Maps	
Transect pictorial guide	
Timed search pictorial guide	
Guidebooks	
Compasses	
Calipers	WD40 after every day in field
Circular plot strings	Check for stretching
Backpacks	
Flagging tape	
Knee pads	
Shade	
Transect tapes	Clean at end of season
Clipboards	Clean at end of season
Rubberbands for clipboards	Replenish if necessary
Pencils	Replenish if necessary
Dry erase markers	Replenish if necessary
Grease pencils (china markers)	Replenish if necessary
Permanent markers (Sharpies)	Replenish if necessary
Logging crayon	Replenish if necessary
Quadrapod	
Extra quads	
Tripod	Clean at end of season
Camera for overview (Nikon)	

Item	Comments
Camera for Photoplots (Olympus 5050)	Assemble, dry run
Underwater housing for camera (Ikelite)	Clean O-rings every season
Underwater strobe with mounting kit	Charge
Desiccant packs	Dry out
Batteries for overview camera	Charge
Batteries for Photoplot camera	Charge
Extra memory cards	
Extra batteries	For cameras and flashlights
Lens cleaner	
Flashlights	Check each one
Drill	Charge
Drill bits	
Z-spar epoxy	
Extra bolts	
Turkey baster	
Hammer	
Cleaning knives, brushes, scrapers, chisels	
Gloves for Zspar	Check, replenish regularly
Ear plugs for fog horn	Check, replenish regularly
Protective gear for drill	Check, replenish regularly
First Aid Kit	Check, replenish regularly
WD40	Stored in the fire cabinet
Radios	Charge
Pocket knife	
Volunteer vests	
Sunscreen	
Snacks	Buy week of sampling
Water	Buy week of sampling

B. ***Activity: Plot Finding and Cleaning***

Maps
Plot guide
Grease pencils
Flagging tape
Permanent markers
Compasses
Transect tapes
Cleaning brushes and knives
Quads

Activity: Circular (Limpet) Plots

Maps and/or plot guides
Logsheets
Clipboard
Pencils
Calipers
Logging crayons
1-m string with loop
Flashlight
Knee pads

Activity: Line Transects

Maps and/or plot guides
Logsheets
Clipboards
Pencils
Transect tapes
Transect pictorial guide
Flagging tape
Permanent markers
Cleaning brushes and knives
Compass
Knee pads

Activity: Fixing Plots

Drill (charged)
Drill bits
Stainless steel bolts
Z-spar
Gloves
Protective gear (eyes and ears)
Turkey baster
Cleaning brushes and knives
Hammer

Activity: Timed Searches

Paper map to draw search area
Logsheet
Clipboard
Pencils
Calipers
Watch
Flashlight
Field guide
Transect pictorial guide

Activity: Photoplots

Maps and/or plot guides
Logsheets
Clipboard
Pencils
Digital Camera
Waterproof housing with wing nuts
Quadrapod
Strobe with arm
Shade
Desiccant
Dry erase pen
Extra batteries
Extra memory cards
Dry rag
Lens cleaner
Extra quads for marking
Flagging tape
Permanent markers
Cleaning brushes and knives

Activity: Overview Photographs

Maps and/or plot guides (for overviews)
Logsheets
Clipboards
Pencils
Digital camera
Tripod
Extra battery

Table 7: Survey Tasks, to be completed every season, with approximate time frame.

A few months before:

- Choose sampling dates
- Recruit volunteers
- Announce dates to staff, volunteers, and collaborators

One month-one week before:

- Send scheduling emails to volunteers (1 month, 2 weeks, 1 week, and 3 days before start)
- Review notes from previous surveys
- Organize gear
- Test Photoplot camera
- Purchase supplies as needed
- Charge batteries (drill, cameras, radio, etc.); dry desiccant if necessary; clean and lubricate o-rings in all Ikelite gear (underwater housing, strobe)
- Photocopy paperwork
- Replenish and update plot guides, maps, pictorial guides

During surveys:

- Conduct volunteer training one half-hour before each sampling day for new volunteers, and for all volunteers for one of each plot type
- Spend first day finding, flagging, cleaning and repairing sites
- Complete Daily Field Log every day
- Plot types/activities:
    - Circular Plots: 6 per zone (8 in Zone II, as of May 2006)
    - Photoplots: 21 per zone (22 in Zone I, as of May 2006)
    - Line Transects: 6 per zone
    - Timed Searches: 30 person minutes per zone
    - Overview Photos: 4 (upper and lower) per zone
    - Zone Observations: 1 per zone every season
    - Site Reconnaissance: 1 per zone every season
- At the end of every day, clean and WD40 calipers; download and label all photographs; total and check numbers of *Lottia* in plots; keep track of plots that have been done and that need repair
- At the end of the season, clean and repair sites if not done at the beginning, and remove flagging tape

After surveys:

- Clean up gear; soak transect tapes in fresh water and dry; WD40 all metal
- Write up notes for next year
- Organize and check logsheets for completeness and legibility; photocopy logsheets and store copy offsite; put originals in storage binder
- Label and organize overview and photoplot photos; create backup copy
- Score photoplot photos
- Stitch overview photos
- Enter data into Tidebase
- Use Tidebase to enter data into MARINe and submit to SCCWRP; we have committed to submit all of our MARINe data by the following dates:
    - Fall data will be submitted by March 1 of the following year (e.g. FA05 by 3/1/06)
    - Spring data will be submitted by July 1 of the same year (e.g. SP06 by 7/1/06)

Table 8: List of Overview Photo Points.

Zone	Overview Photo Point	Latitude	Longitude
I	MOV01	32.669481	-117.244625
I	MOV02	32.669494	-117.244769
I	MOV03	32.669136	-117.244672
I	MOV04	32.669056	-117.244308
II	MOV21	32.668031	-117.244161
II	MOV22	32.667353	-117.244406
II	MOV23	32.667814	-117.244311
II	MOV25	32.666572	-117.243717
III	MOV31	32.666094	-117.243297
III	MOV32	32.664611	-117.242294
III	MOV33	32.664331	-117.241683
III	MOV34	32.665361	-117.243192

Table 9: List of Tables in Tidebase. Includes basic descriptions that are listed under properties**.**

Table Name	Table Description
luAbundanceCodes	Codes used by MARINe for the abundances in Site Recon.
luCRIMPSpeciesList	Species list for Cabrillo, including past names and which monitoring technique. Should link to MARINe lists.
luDamageCodes	Codes used by MARINe for the damage in Site Recon.
luEventList	List of events made consistent with MARINe.
luFieldLogCodes	Codes used by MARINe for the Field Log.
luLottiaSizes	A list of possible Lottia sizes, used for data entry purposes.
luMarineMammalList	A list of required marine mammal species.
luOfficialSpeciesListImported	MARINe Species List. New Species List created 5/17/05 at UCSB with Larry, Jack, and Melissa. This table is imported and is not necessarily up to date. Should be re-imported occasionally to update the species names.
luPersonnelAssociations	List of basic association of participants, if known. Most are just listed as VIPs.
luPersonnelList	List of all participants over time.
luSiteList	List of site #, Zone, and plot #. Linked to the MARINe table to keep current on the target species.
luTimedSearchTargetSpecies	The list of target species for the MARINe required species for timed searches. The target species names will not update automatically; this needs to be done in the table itself.
luZones	List of Zones for drop-down boxes.
MluMethods	Linked Table from MARINe (luList04_Methods), with a list of methods used.
MluOfficialSpeciesList	MARINe official Species List. This is a linked table and will remain updated. Can re-import it (luOfficialSpeciesListImported) to maintain the relationships, but be careful not to have cascading deletes in the Official CRIMP species list.
MtblFieldLogEvent	MARINe table that is linked in order to use it for data entry.
MtblPhotoPlots	MARINe table that is linked in order to use it for data entry.
MtblPhotoPlotSiteInfo	MARINe table tblPhotoPlotInfo (linked)
MtblReconnaissance	MARINe table that is linked in order to use it for data entry.
MtblSpeciesCountSize	MARINe table that is linked in order to use it for data entry.
MtblTransects	MARINe table that is linked in order to use it for data entry.
MtblTransectSiteInfo	MARINe table tblTransectInfo (linked).
tblDailyFieldLog	Field Log data for the day, not done per zone.
tblDailyParticipants	List of who worked on any given day.
tblLottiaData	This table is the actual data for Lottia. It is linked to tblLottiaInfo for the date, recorder, comments, etc.
tblLottiaInfo	The date, scorer, notes, etc. for data in tblLottiaData
tblLottiaMeasurers	This table links the measurers to the tblLottiaInfo. There can be multiple measurers for a plot.
tblPhotoplotData	This table is the actual data for the photoplots. It is linked to tblPhotoplotInfo for the date, recorder, comments, etc.
tblPhotoplotInfo	The date, scorer, notes, etc. for data in tblPhotoplotData
tblSiteReconData	The Site Recon data for a single zone and single season. The info is in tblSiteReconInfo.

Table Name	Table Description
tblSiteReconInfo	The info about Site Recon for a single zone and single season. The data are in tblSiteReconData.
tblTimedSearchData	This tableis the actual data for timed searches. It is linked to tblTimedSearchInfo for th edate, recorder, comments, etc.
tblTimedSearchInfo	The date, scorer, notes, etc. for data in tblTimedSearchData
tblTransectData	The transect data, stored as total numbers for the taxa rather than each individual point along the transect. Legacy data was converted to this format, original data in earlier databases.
tblTransectInfo	The date, scorer, notes, etc. for Transect data.
tblTransectMeasurers	This table links the measurers to the tbTransectsInfo. There can be multiple measurers for a Transect.
tblTransectSurfgrassSupplData	This is the additional info on the health of surfgrass. I don't see a place this belongs in MARINe, so I will keep it separate.
tblZoneLog	Field Log data for the zone, not done per day, just once in the season (Zone Observatios).
xxxEnterTransects	This is a table used by the form for entering Transect data. Do not delete it, or the form will not work.
xxxLegacyTransectData1	This is the oldest Transect data, stored by individual point rather than taxa totals. This set was line-intercept.
xxxLegacyTransectData2	This is the second oldest Transect data, stored by individual point rather than taxa totals. This set was point-intercept but no Surfgrass Understory.
xxxLegacyTransectData3	This is the third oldest Transect data, which was stored as taxa totals rather than individual points. This was a season when we were trying to conform to MARINe standards, but we eventually shifted back to the storage by point because it was easier
xxxLegacyTransectData4	This is the fourth oldest Transect data, stored by individual point rather than taxa totals. This set was point-intercept with Surfgrass Understory.
xxxOffseasonLog	This is a casual table for recording odd events that do not fall during regular monitoring.
xxxPersonnelComments	Comments about a person that had been noted over time. Will need to improve this system, but I didn't want to lose this information.

<u>Figure 1:</u> Map of CABR showing tidepool zones and roads.

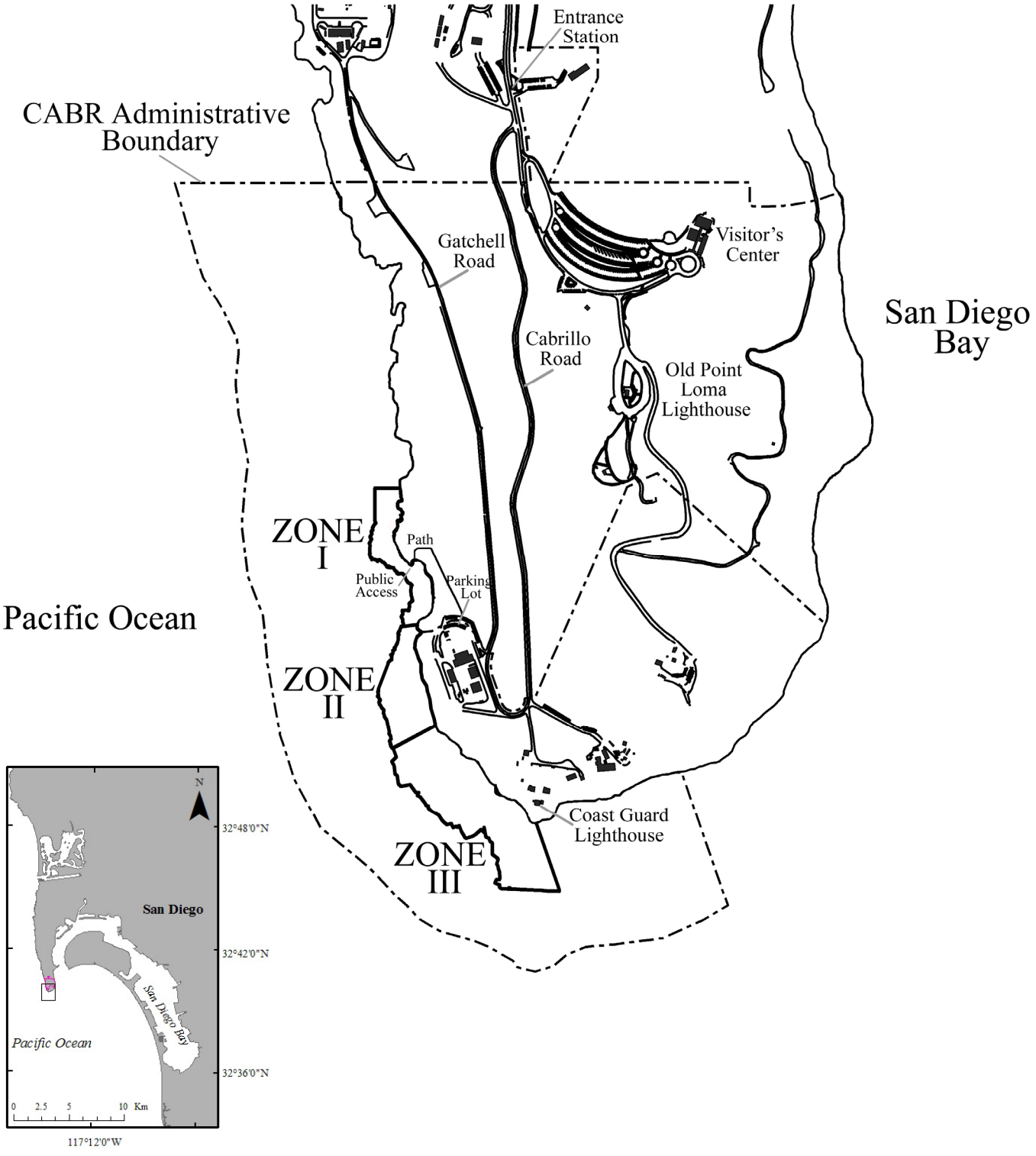


Figure 2: **Map of CAB1**

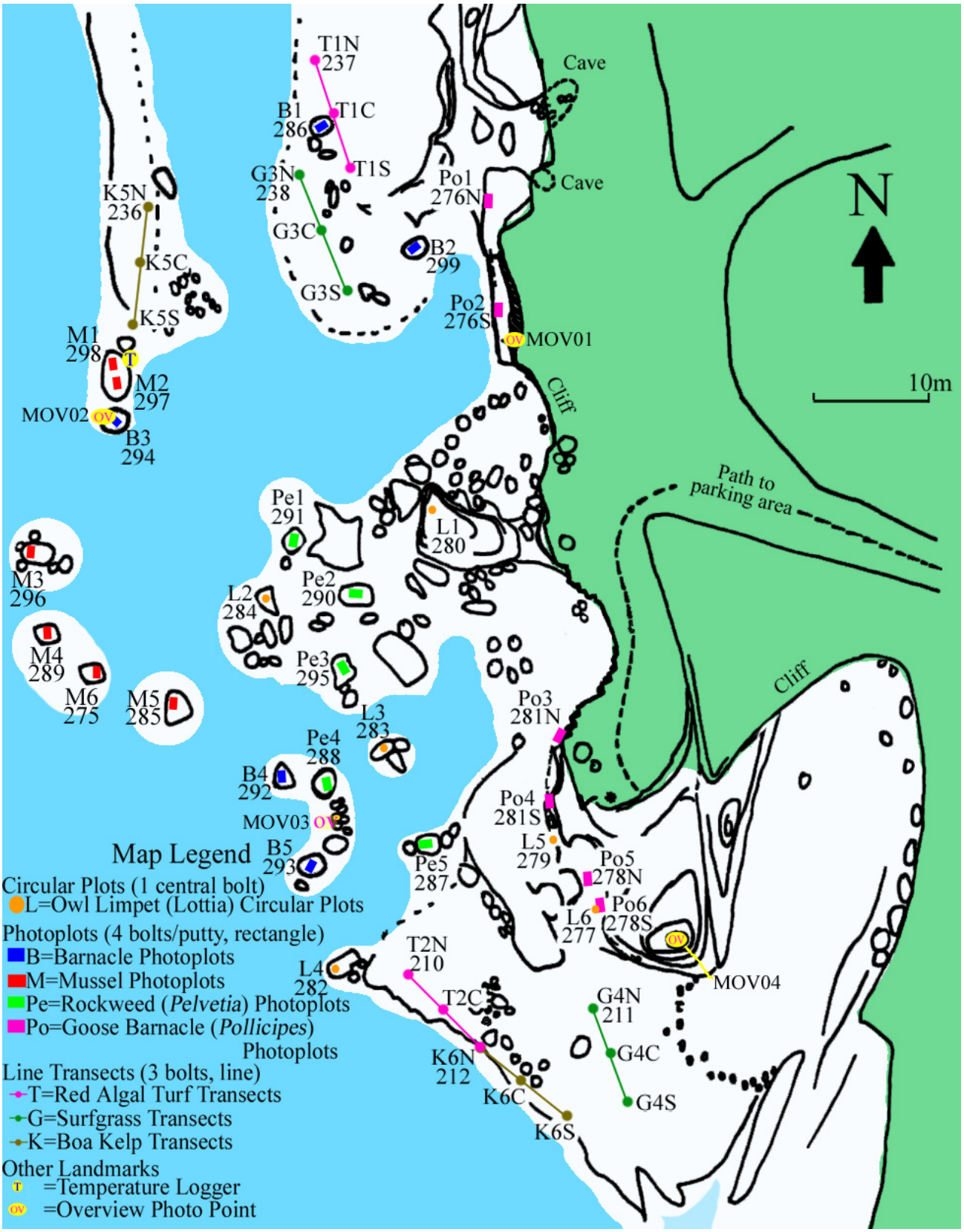


Figure 3: **Map of CAB2**

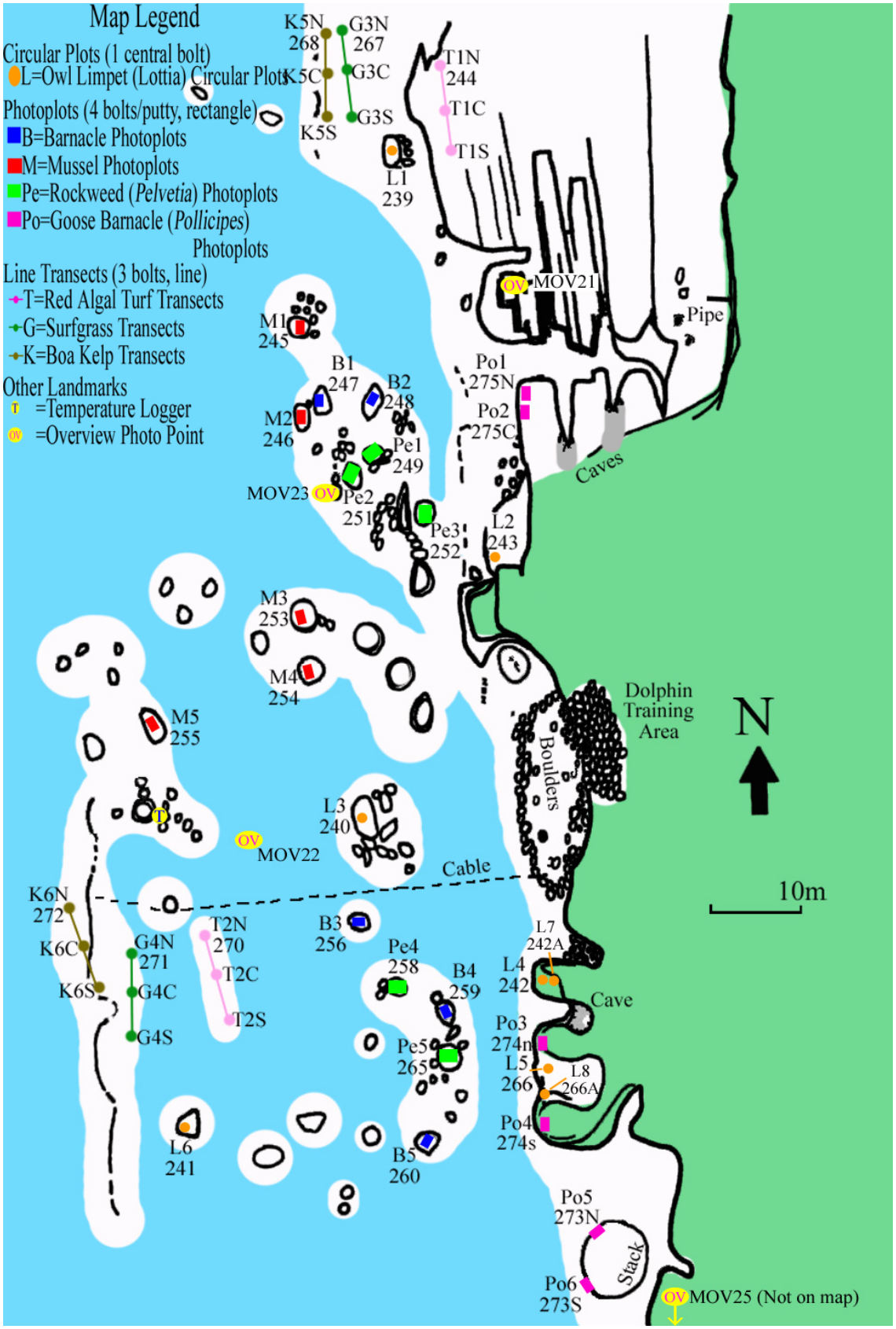
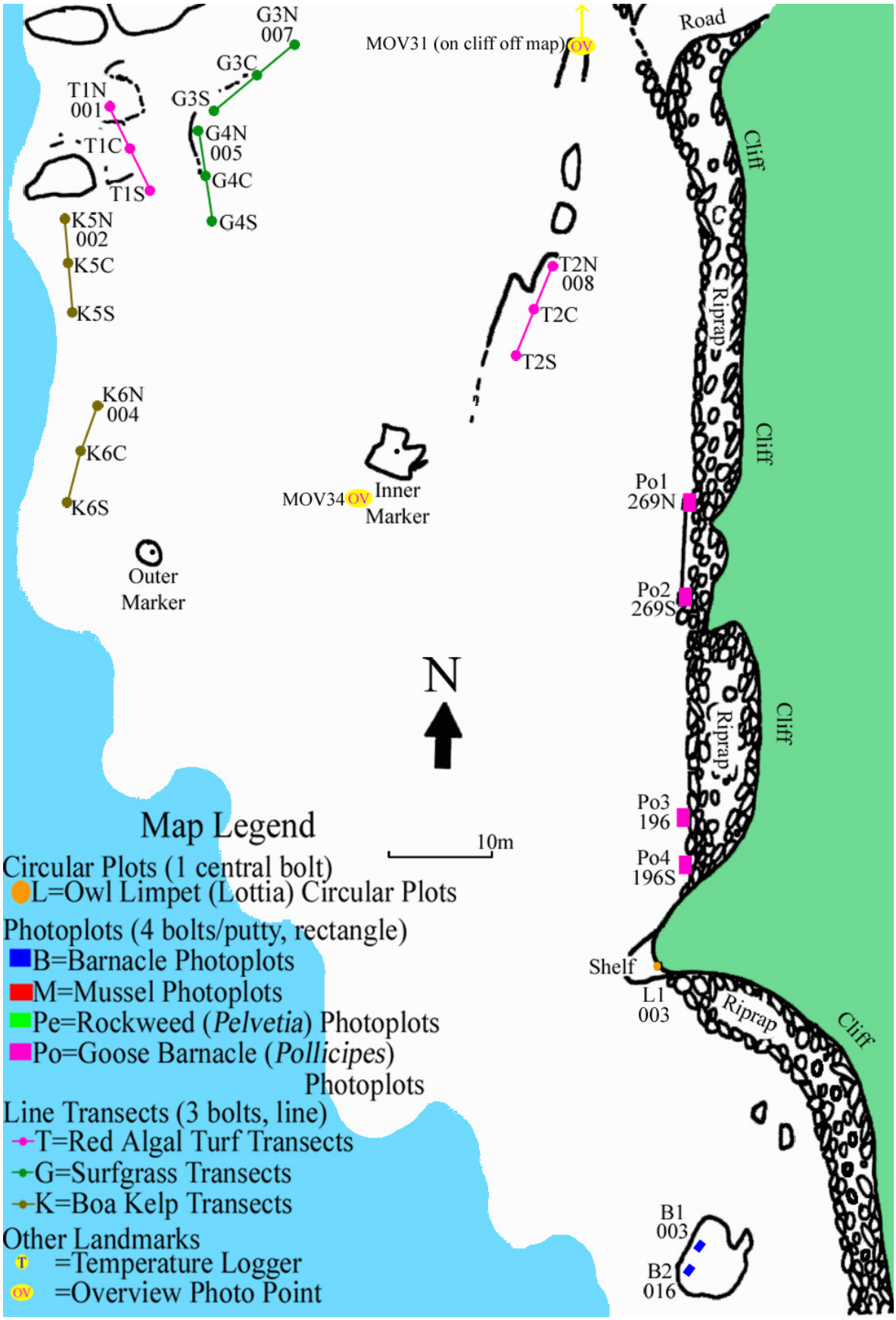
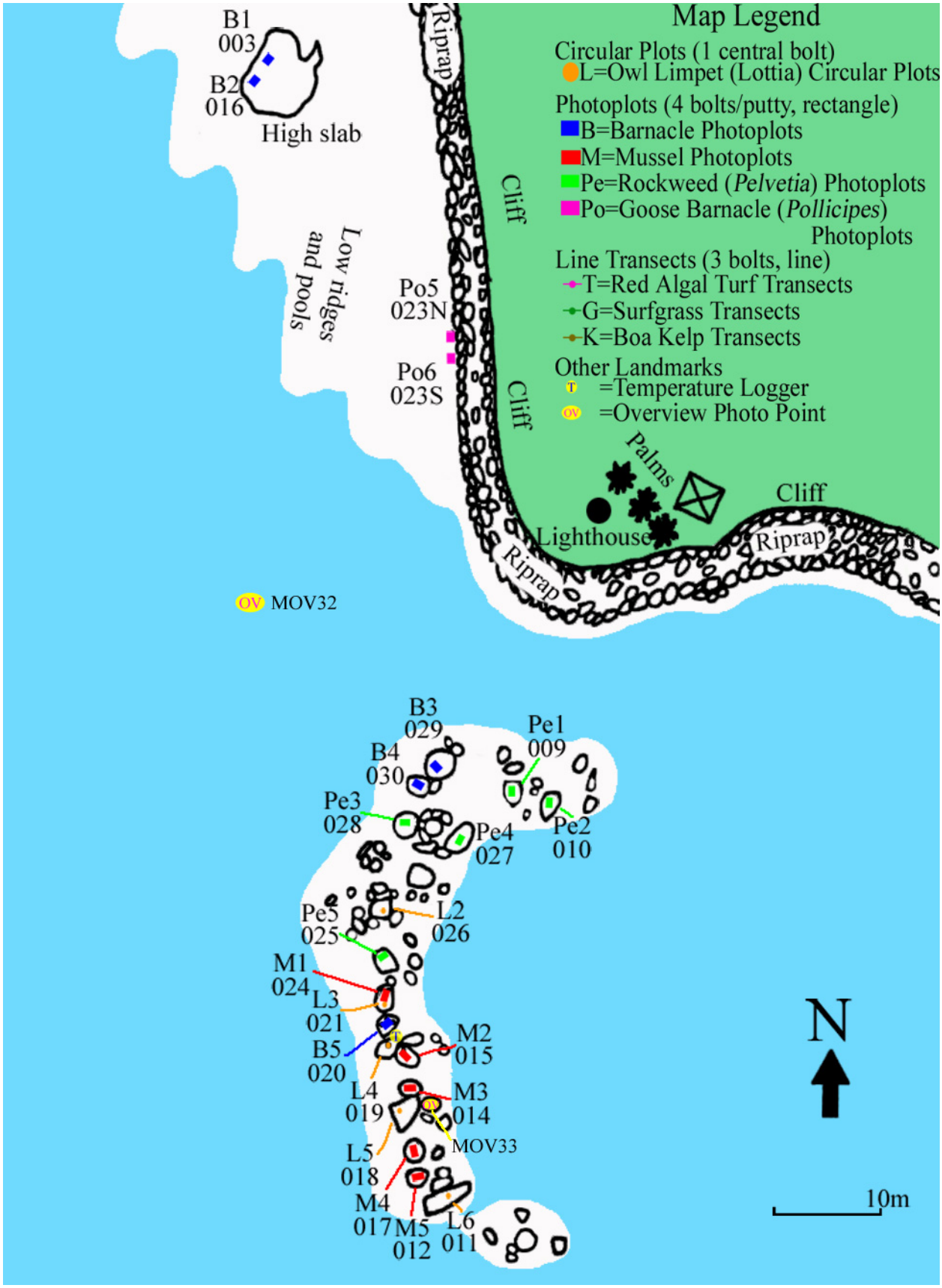


Figure 4: Map of CAB3. A. Northern section, B. Southern section.

A.



B.


Map Legend
Circular Plots (1 central bolt)
L=Owl Limpet (Lottia) Circular Plots
Photoplots (4 bolts/putty, rectangle)
B=Barnacle Photoplots
M=Mussel Photoplots
Pe=Rockweed (Pelvetia) Photoplots
Po=Goose Barnacle (Pollicipes) Photoplots
Line Transects (3 bolts, line)
T=Red Algal Turf Transects
G=Surfgrass Transects
K=Boa Kelp Transects
Other Landmarks
T =Temperature Logger
OV =Overview Photo Point
B1 003
B2 016
High slab
Riprap
Cliff
Low ridges and pools
Po5 023N
Po6 023S
Cliff
Palms
Cliff
Lighthouse
Riprap
Riprap
OV MOV32
B3 029
Pe1 009
B4 030
Pe3 028
Pe4 027
Pe2 010
Pe5 025
L2 026
M1 024
L3 021
B5 020
M2 015
L4 019
M3 014
MOV33
L5 018
M4 017
M5 012
L6 011
N
10m

<u>Figure 5:</u> Quadrapod design. A. The basic parts of the quadrapod, including the bottom base, the upper base, and four legs; B. the quadrapod assembled with the digital camera, and underwater case and strobe; C. in the field it is often convenient to take the middle bar apart to carry the heavy camera separately from the awkward frame; D. closeup of the strobe setup using the Olympus 5050/Ikelike setup from May 2006.

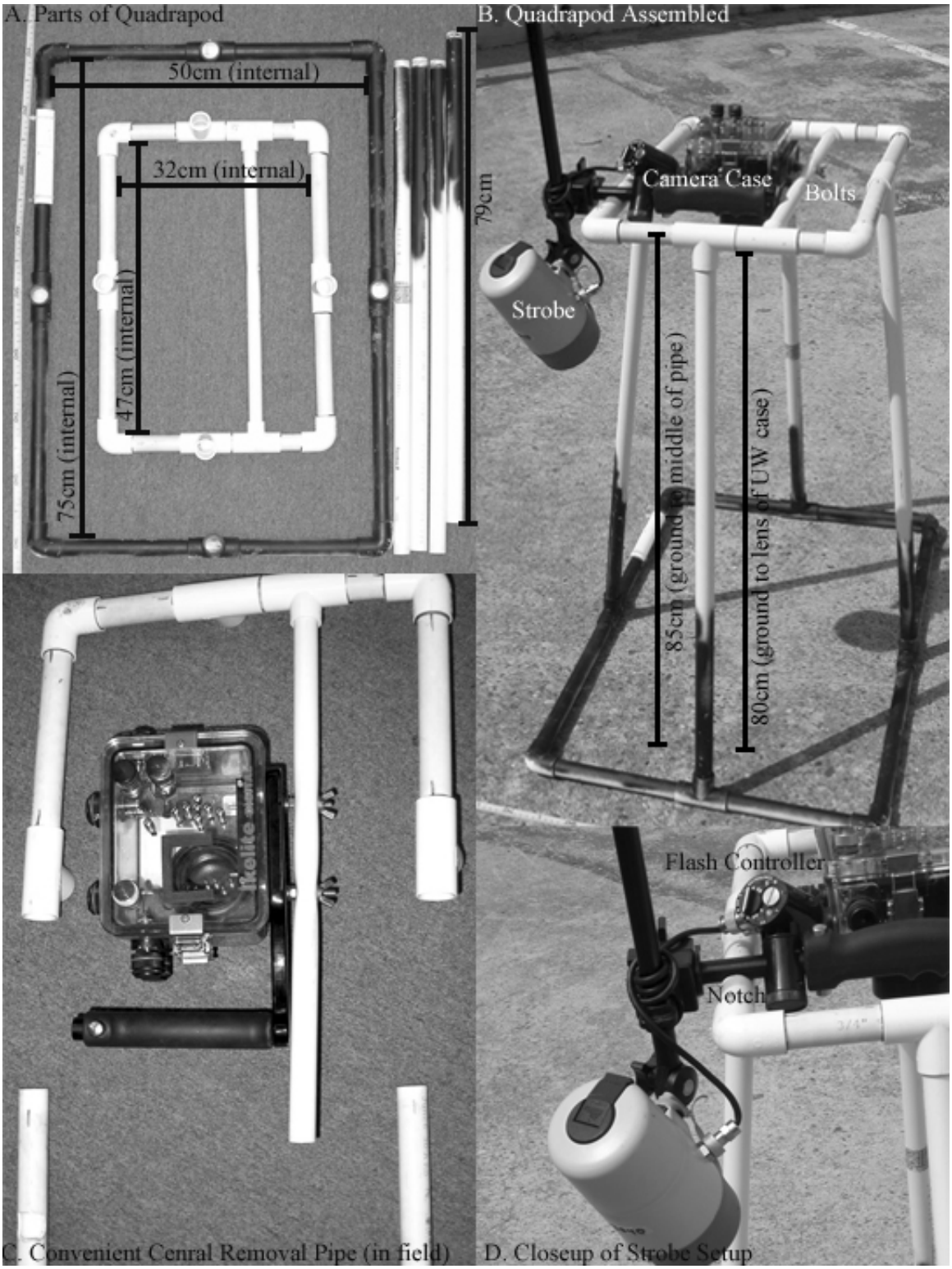


Figure 6: Relationships among major tables of Tidebase.

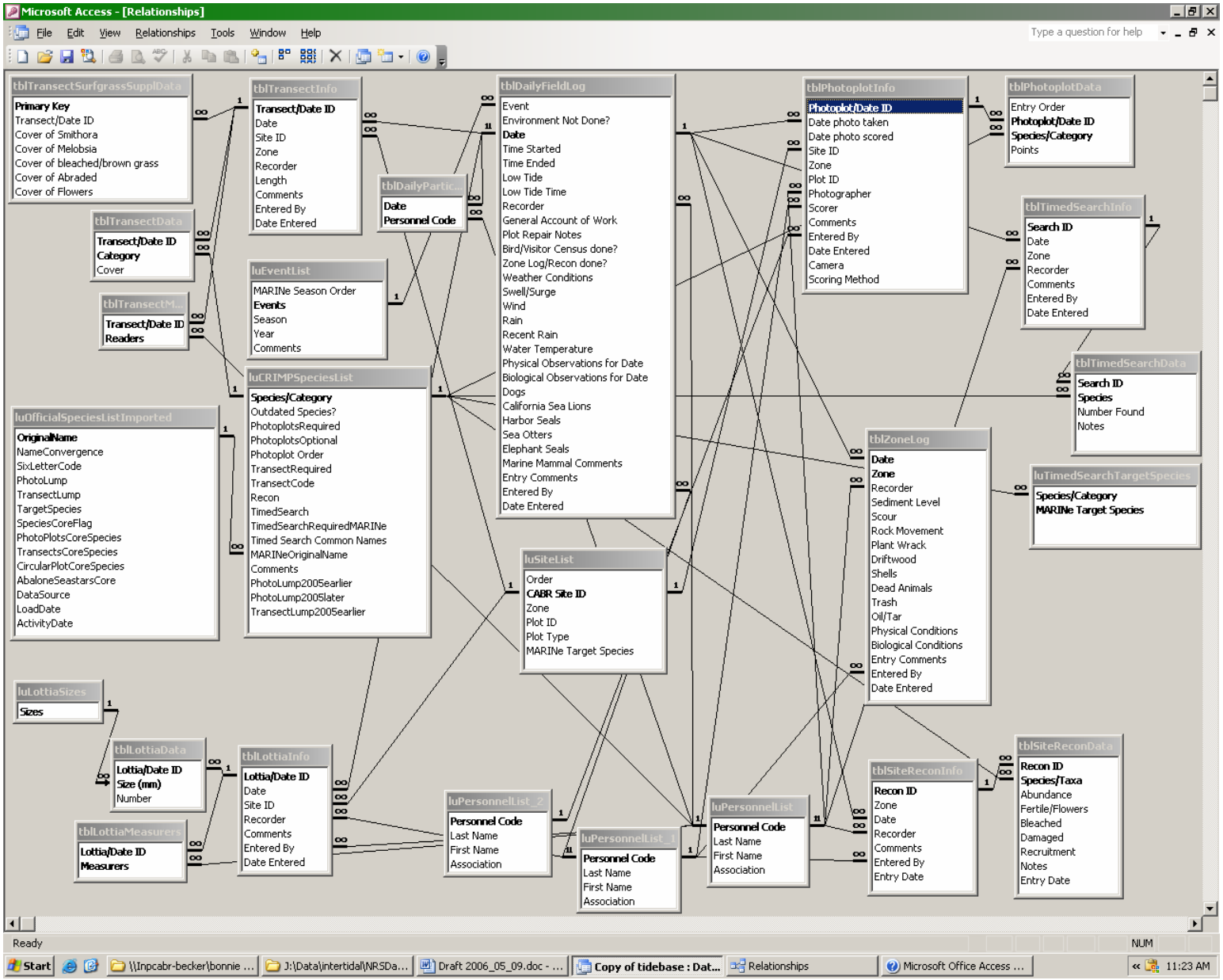


Figure 7: Tidebase switchboard. The switchboard opens automatically when Tidebase opens. If this switchboard is accidentally closes, it can be reopened under "Forms">"Form: Main Switchboard"

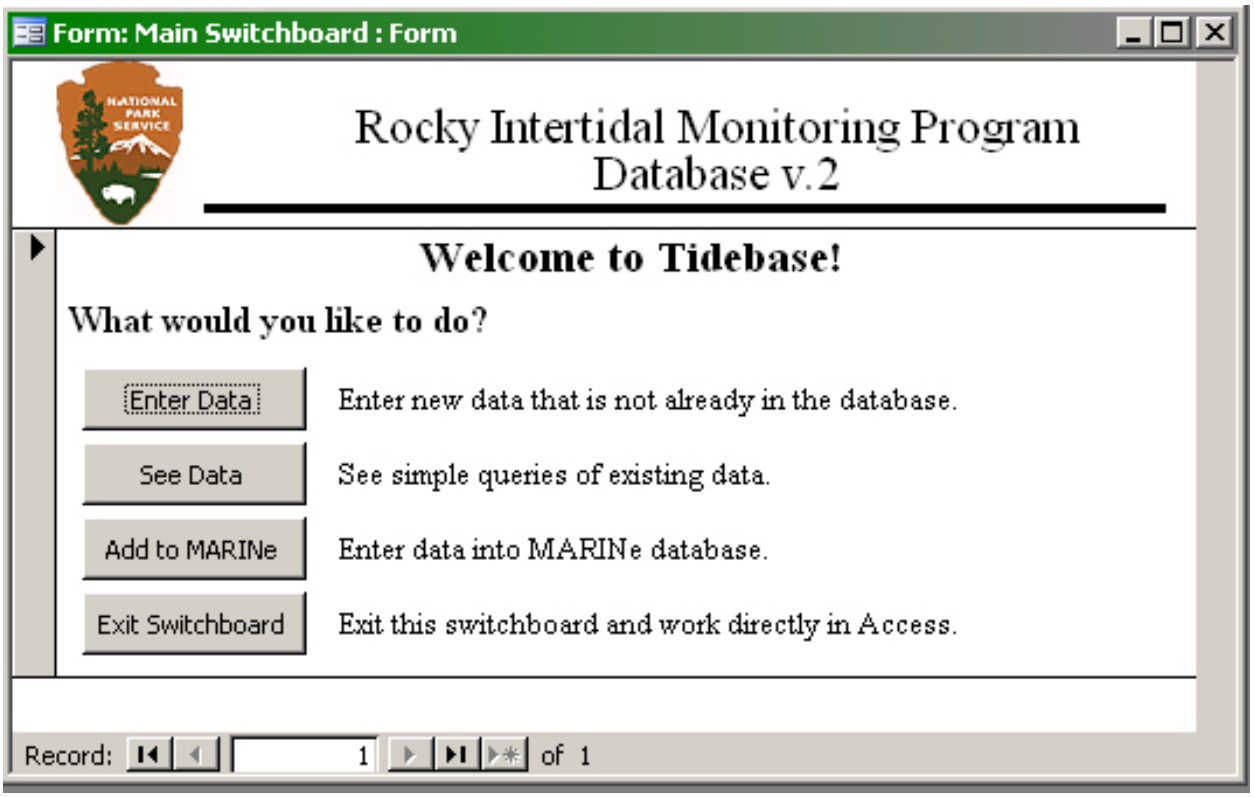


Figure 8: Main Data Entry Form for Tidebase.